DEPARTMENT OF BIOTECHNOLOGY

B. Tech. – Biotechnology

CURRICULUM AND SYLLABUS

2021

KALASALINGAM ACADEMY OF RESEARCH AND EDUCATION
(Deemed to be University)
Anand Nagar, Krishnankoil - 626 126

Institute Vision	**Institute Mission**
To be a University of Excellence of International Repute in Education and Research	1. To provide a scholarly teaching learning ambience which results in creating graduates equipped with skills and acumen to solve real-life problems 2. To promote research and create knowledge for human welfare, rural and societal development 3. To nurture entrepreneurial ambition, industrial and societal connect by creating an environment through which innovators and leaders emerge.
Department Vision	**Department Mission**
To be a department of excellence in quality education and research in the multidisciplinary areas of Biotechnology.	1. To imbibe the ability of critical thinking, scholastic attitude and provide solutions for critical problems. 2. To embed acumen of life-long learning and zeal to pursue research in various disciplines of Biotechnology. 3. To nurture the ability to create sustainable solutions with a blend of socio-ethical understanding.

Program Educational Objectives (B.Tech - Biotechnology)

PEO1 - Graduates will attain a general level of competence in order to pursue advanced courses and / or acquire specialized training and skills relevant to their professions.

PEO2 - Graduates will be engineering practitioners and leaders in public and private sector undertakings, who would help solve industry's technological problems and serve our society.

PEO3 - Graduates will learn to uphold ethical conduct in their professions, have effective communication skills, and an affinity towards lifelong learning.

Program Outcomes

Engineering Graduates will be able to:

1. **Engineering Knowledge**: Apply the knowledge of mathematics, science, engineering fundamentals, and an engineering specialization to the solution of complex engineering problems.

2. **Problem Analysis**: Identify, formulate, review research literature, and analyze complex engineering problems reaching substantiated conclusions using first principles of mathematics, natural sciences, and engineering sciences.

3. **Design/development of Solutions**: Design solutions for complex engineering problems and design system components or processes that meet the specified needs with appropriate consideration for the public health and safety, and the cultural, societal, and environmental considerations.

4. **Conduct Investigations of Complex Problems**: Use research-based knowledge and research methods including design of experiments, analysis and interpretation of data, and synthesis of the information to provide valid conclusions.

5. **Modern Tool Usage**: Create, select, and apply appropriate techniques, resources, and modern engineering and IT tools including prediction and modeling to complex engineering activities with an understanding of the limitations.

6. **The Engineer and Society**: Apply reasoning informed by the contextual knowledge to assess societal, health, safety, legal and cultural issues and the consequent responsibilities relevant to the professional engineering practice.

7. **Environment and Sustainability**: Understand the impact of the professional engineering solutions in societal and environmental contexts, and demonstrate the knowledge of, and need for sustainable development.

8. **Ethics**: Apply ethical principles and commit to professional ethics and responsibilities and norms of the engineering practice.

9. **Individual and Team Work**: Function effectively as an individual, and as a member or leader in diverse teams, and in multidisciplinary settings.

10. **Communication**: Communicate effectively on complex engineering activities with the engineering community and with society at large, such as, being able to comprehend and write effective reports and design documentation, make effective presentations, and give and receive clear instructions.

11. **Project Management and Finance**: Demonstrate knowledge and understanding of the engineering and management principles and apply these to one's own work, as a member and leader in a team, to manage projects and in multidisciplinary environments.

12. **Life-Long Learning**: Recognize the need for, and have the preparation and ability to engage in independent and life-long learning in the broadest context of technological change.

Program Specific Objectives (PSO)

Engineering Graduates will be able to:

PSO1: Identify and analyze the problems related to biopharmaceutical production, agricultural production and bioinformatics, and develop solutions to these through appropriate methods, aided by their knowledge of engineering.

PSO2: Apply their knowledge for the investigation of complex problems in the manufacture of biological products; and in the prevention, diagnosis and treatment of diseases, using cutting–edge technologies, to promote the health and well–being of society.

PSO3: Recognize the need for a clean environment and optimize the use of natural resources for sustainability, either individually or as a team, governed by ethical considerations.

B.TECH. BIOTECHNOLOGY

CURRICULUM STRUCTURE

S.No	Curriculum Component		Credits
I	Foundation Core		44
II	Program Core		52
III	Program Elective		24
IV	University Elective Courses		16
V	Experiential Core		16
	Design Project	6	
	Capstone	10	
VI	Experiential Elective (CSP/Internship/UG Research /Competitions)		8
Total Credits			**160**

FOUNDATION CORE COURSES

S. No.	Course Code	Course name	L	T	P	X	C
1.	211ENG1301	English for Engineers	2	0	0	3	3
2.	211PHY1301	Physics	3	0	2	0	4
3.	211MAT1301	Calculus and Linear Algebra	3	2	0	0	4
4.	211MEC1201	Introduction to Engineering Visualization	0	0	2	3	2
5.	211CSE1401	Problem Solving using computer Programming	1	0	2	3	3
6.	211BIT1101	Biology for Engineers	3	0	0	0	3
7.	211EEE1301	Basic Electrical and Electronics Engineering	3	0	2	0	4
8.	211CHY1301	Chemistry	3	0	2	0	4
9.	211MAT1303	Multiple Integration, ODE and complex variable	3	0	2	0	4
10.	211MEC1401	Sustainable Design and Manufacturing	1	0	2	3	3
11.	211CSE1402	Python Programming	1	0	2	3	3
12.	211ECE1301	IoT Sensors and Devices	1	0	0	3	2
13.	211MEC1301	Innovation and Entrepreneurship	1	0	0	3	2
14.	211MAT1302	Statistics for Engineers	2	0	0	3	3
		Credits					**44**

PROGRAMME CORE COURSES

S. No.	Course Code	Course name	L	T	P	X	C
1	212BIT1301	Microbiology	3	0	2	0	4
2	212BIT1302	Biochemistry	3	0	2	0	4
3	212BIT1303	Cell and Molecular Biology	3	0	2	0	4
4	212CHE1304	Principles of Chemical Engineering	3	1	2	0	5
5	212BIT1304	Bioinformatics	3	0	2	3	5
7	212BIT2305	Bioprocess Principles	3	1	2	0	5
8	212BIT2306	Genetic Engineering	3	1	2	0	5
9	212BIT3307	Biochemical Engineering	3	1	2	3	6
10	212BIT3308	Immunology	3	1	2	0	5
11	212BIT3309	Bio separations: Principles and Applications	3	1	2	3	6
12	212MAT2302	Numerical Methods and Laplace Transforms	3	0	0	0	3
		Credits					**52**

PROGRAMME ELECTIVE COURSES

S. No.	Course Code	Course name	L	T	P	C
1.	213BIT1101	Genetics	3	0	0	3
2.	213BIT1102	Human Anatomy and Physiology	3	0	0	3
3.	213BIT1103	Bioorganic Chemistry	3	0	0	3
4.	213BIT1104	Industrial Biotechnology	3	0	0	3
5.	213BIT1105	Protein Science and Engineering	3	0	0	3
6.	213BIT1106	Food Processing and Technology	3	0	0	3
7.	213CHE1122	Reaction Engineering for Biotechnologists	3	0	0	3
8.	213CHE1123	Mass Transfer	3	0	0	3
9.	213BIT2107	Clinical Biochemistry	3	0	0	3
10.	213BIT2108	Environmental Biotechnology	3	0	0	3
11.	213BIT2109	Healthcare Biotechnology	3	0	0	3
12.	213BIT2110	Enzyme Technology	3	0	0	3
13.	213BIT2111	Agricultural Biotechnology	3	0	0	3
14.	213BIT2112	Bioenergy	3	0	0	3
15.	213BIT2113	Drug Design and Development	3	0	0	3
16.	213BIT2114	Infectious Diseases	3	0	0	3
17.	213BIT3115	Animal Biotechnology	3	0	0	3
18.	213BIT3116	Plant Biotechnology	3	0	0	3
19.	213BIT3117	IPR in Biotechnology	3	0	0	3
20.	213BIT3118	Bioreactor Design and Analysis	3	0	0	3
21.	213BIT3119	Biosensors	3	0	0	3
22.	213BIT3120	Molecular Diagnostics and Therapeutics	3	0	0	3
23.	213BIT3121	Radiation Biology	3	0	0	3
24.	213BIT3122	Clinical Trials and Management	3	0	0	3
25.	213BIT3123	Biomaterials	3	0	0	3
26.	213BIT3124	Entrepreneurship in Biotechnology	3	0	0	3
27.	213BIT3125	Stem Cell Technology	3	0	0	3
28.	213BIT3126	Cell Culture Technologies	3	0	0	3
29.	213BIT3127	Evolutionary Biology	3	0	0	3
30.	213BIT3128	Tissue Engineering	3	0	0	3

HONORS COURSES

S. No.	Course Code	Course name	L	T	P	C
1.	217BIT1101	Analytical Techniques in Biotechnology	3	0	0	3
2.	217BIT1102	Biophysics	3	0	0	3
3.	217BIT1103	Nanobiotechnology	3	0	0	3
4.	217BIT2104	Metabolic Engineering	3	0	0	3
5.	217BIT2105	Molecular Pathogenesis	3	0	0	3
6.	217BIT2106	Cancer Biology	3	0	0	3
7.	217BIT2107	Plant Bioinformatics	3	0	0	3
8.	217BIT3108	Functional Genomics	3	0	0	3
9.	217BIT3109	Recombinant Protein Production	3	0	0	3
10.	217BIT3110	RNAi Technology	3	0	0	3
11.	217BIT3111	Vaccinology	3	0	0	3
12.	217BIT3112	Bioprocess Instrumentation and Control	3	0	0	3
13.	217BIT3113	Transport Phenomena in Biological Systems	3	0	0	3
14.	217BIT3114	Signal Transduction	3	0	0	3
15.	217BIT3115	Structural Biology	3	0	0	3
16.	217BIT3116	Systems Biology	3	0	0	3

UNIVERSITY ELECTIVES

S. No.	Course Code	Course name	L	T	P	C
1.	214BIT1101	Introduction to Computational Biology	3	0	0	3
2.	214BIT1102	Exploring the Microbial World	3	0	0	3
3.	214BIT1103	Human Diseases and Prevention	3	0	0	3
4.	214BIT1104	Environmental Microbiology	3	0	0	3
5.	214BIT1105	Bioresource Technology	3	0	0	3
6.	214BIT1106	Biological Wastewater Treatment	3	0	0	3
7.	214BIT1107	Bio-Corrosion	3	0	0	3
8.	214BIT1108	Biology of Cancer	3	0	0	3
9.	214BIT1109	Engineering of Crop plants	3	0	0	3
10.	214BIT1110	Gene Manipulation	3	0	0	3

SYLLABUS

FOUNDATION CORE

211ENG1301	ENGLISH FOR ENGINEERS	L	T	P	X	C
		2	0	0	3	3

Course Description

The course is designed to help develop the communicative performance of Engineers from various disciplines who wish to improve their abilities in English.

Course Outcomes:

CO1: To learn domain and business related vocabulary
CO2: To develop professional writing skills pertaining to various workplace communication.
CO3 To listen and comprehend various types of intermediate professional talks, speeches, interviews
CO4: To speak at ease with various stakeholders while at work
CO5: To read and comprehend information quickly with technical perspectives

Mapping of Course Outcomes:

CO / PO	PO												PSO		
	1	2	3	4	5	6	7	8	9	10	11	12	1	2	3
CO1										H					H
CO2										H					H
CO3										H					H
CO4										H					H
CO5										H					H

Unit I

Grammar- Tenses & application of right tenses in different situations– Part 1, Vocabulary- Context Clues and leading to word map/word cloud, Reading- Stages in reading: Pre-reading, during-reading & post-reading, Writing- E-mails, Notices, Memos, Instructions/Information Writing, Listening- Types of Listening, Spoken/Written Production- Interpretation of Graphical Data.

Unit II

Grammar- Tenses & application of right tenses in different situations – Part 2, Vocabulary- Phrasal Verbs & Idioms Reading- Identifying main idea & supporting details-Writing- Report Writing – Understanding reports, principles and purpose, Listening- Listening for Gist,Spoken Production- Presentation techniques &stages.

Unit III

Grammar- Prepositions & Prepositional Phrases , Vocabulary- One Word Substitution – Word/phrase choice , Reading- Making Predictions, Inferences& Drawing Conclusions , Writing- Proposal Writing – Principles of proposal writing, purpose and outcome , Listening- Listening for specific information , Spoken Interaction- Giving instructions/directions.

Unit IV

Grammar- Active Voice & Passive Voice – differences and functions , Vocabulary- Cohesive devices and transitional words , Reading- Skimming and Scanning – purpose and techniques, Writing- Instructions & Recommendations , Listening- Product Description, Spoken Production- Engaging audience using anecdotes/illustrations.

Unit V

Grammar- Subject-Verb & Pronoun-Antecedent Agreements, Vocabulary- Collocations , Reading- Identifying Cause and Effect , Writing- Resume Writing – Understanding the objective, inclusions and exclusions , Listening- Telephonic conversations/ Interviews, Spoken Production- Persuading and Negotiating.

Textbooks

1. Dubey, ShyamJi, Manish Kumar and Shreesh Chaudhary. English for Engineers. Chennai: Vikas Publishing House, 2020.
2. Raman, Meenakshi and Sangeeta Sharma. Technical Communication: Principles andPractice. New Delhip: Oxford University Press. 2010.
3. Sudharshana. N.P. and C. Savitha. English for Engineers. Delhi: Cambridge University Press, 2015.

Reference Books:

1. Greenbaum, Sidney. Oxford English Grammar. London: Oxford University Press, 2005.
2. Oshima, A, Hogue, A. Writing Academic English. New York: Pearson Longman, 2006.

211PHY1301	PHYSICS	L	T	P	X	C
		3	0	2	0	4

Course Objectives

- To impart fundamental physics concepts applicable to engineering applications
- To introduce technological advances into engineering applications.

Course Outcomes (CO)

CO1: Describe the properties of magnetic and Dielectric materials
CO2: Understand the basic concepts of Mechanics and Thermodynamics
CO3: Understand the types, properties and applications of semiconductors
CO4: Understand the use of Lasers and Fiber optics
CO5: Understand the quantum Mechanics and its applications

Mapping of Course Outcomes:

CO / PO	PO												PSO		
	1	2	3	4	5	6	7	8	9	10	11	12	1	2	3
CO1	H	H												M	
CO2	H	H												M	
CO3	H	H												M	
CO4	H	H												M	
CO5	H	H												M	

UNIT -I: Magnetic Materials

Origin of magnetic moment - Classification of magnetic materials (Dia, Para, Ferro) - Domain theory of Ferromagnetism - Hysteresis curve - soft and hard magnetic materials - Applications in different fields (qualitative)

Dielectric Materials

Dielectrics - Dielectric constant - electronic, ionic, orientational and space charge polarization - frequency and temperature dependence of polarization - dielectric breakdown mechanisms- Applications of dielectrics (Qualitative)

UNIT – II: Mechanics

Moment of inertia (M.I) - Radius of gyration – parallel axes theorem – perpendicular axes theorem - M.I of rod, circular disc, solid cylinder, hollow cylinder, solid sphere and hollow sphere (Qualitative) - K.E of a rotating body - Torsional pendulum.

Thermodynamics: Zeroth Law of thermodynamics - first law of Thermodynamics - Work done by a gas - Heat engines - second law of Thermodynamics - Reversible and Irreversible process – Entropy - Carnot Engine - Newton's law of cooling.

UNIT – III: Semiconductors

Stages of electron theory of solids (Qualitative) – Fermi - Dirac distribution function F(E) – Effect of temperature on F(E) - Density of states for metals(conductors) - Intrinsic semiconductors - carrier concentration (derivation) - Fermi energy, Variation of Fermi energy level with temperature - Mobility and electrical conductivity - Band gap determination - Extrinsic semiconductors (Qualitative) - Hall effect - Determination of Hall coefficient - applications.

UNIT – IV: Laser

Principle of spontaneous and stimulated emission - Einstein’s A & B coefficients (Derivation) - population inversion - metastable state - pumping methods – Characteristics of laser - types of lasers, gas lasers CO_2 laser - solid-state lasers (Nd-YAG), applications of lasers in science, engineering and medicine.

Fiber Optics: Introduction to optical fiber - Total internal reflection - Structure of optical fibre - Propagation of lightin an optical fibre(Numerical aperture and Acceptance angle) (Derivation),

Types of optical fibre, Fibre optic communication system – fibre optic sensors, Temperature/Pressure sensor – Displacement sensor.

UNIT – V: Quantum Mechanics

Introduction to quantum physics - black body radiation - Planck's hypothesis and Planck's blackbody radiation(derivation) – Deduction of Rayleigh jeans law – Deduction of Wien's displacement law – Physical significance of wave function - Schrodinger time independent wave equation, time dependent wave equation, particle in a box (1D), Electron microscope – Scanning electron microscope.

Text Book(s):

1. Engineering Physics II, P. Mani, Dhanam Publications,
2. Properties of matter, R. Murugesan, S. Chand Publications
3. Heat and thermodynamics, Brij Lal, N. Subramanyam, P.S. Hemne, S. Chand Company Pvt. Ltd,2015.
4. Engineering Physics I, P.Mani, Dhanam Publications

Reference Book(s):

1. Engineering Physics, Marikani A, 3rd Edition, PHI Learning Pvt. Ltd, 2020
2. Engineering Physics, Amit Sarin and Anil Rewal, Wiley, 2014
3. Engineering Physics, Shatendra Sharma and Jyotsna Sharma, 1st Edition, Pearson, 2018
4. Concepts of Physics, Volume 2, H C Verma, Bharathi Bhawan Publishers, New Delhi, 2019.
5. Fundamental of Physics, David Halliday, Robert Resnick, Jearl Walker, 11th Edition, Wiley,2018

211MAT1301	CALCULUS AND LINEAR ALGEBRA	L	T	P	X	C
		3	0	2	0	4

Course Objective

To enable the students to understand the prime perceptions of one and two dimensional calculus and to solve systems of linear equations; to find and reduce to canonical form using the Eigenvalues and Eigenvectors of matrices and apply them to solve real life problems.

Course Outcomes

CO1: Solve the system of linear equations; find Eigenvalue and Eigenvector and diagonalization of matrices
CO2: Understand the concepts of vector space and linear independent, dependent of vectors
CO3: Know the applications of differentiation by series expansion of function, using Taylor's and Maclaurin's theorems and by finding maxima and minima.
CO4: Recognize the method of finding limit and derivative of functions and maxima,minima in two variables
CO5: Grasp about evolutes and simple applications of one-dimensional calculus.

Mapping of Course Outcomes:

CO / PO	PO												PSO		
	1	2	3	4	5	6	7	8	9	10	11	12	1	2	3
CO1	S											L		M	
CO2		S												M	
CO3	S											L		M	
CO4		L												M	
CO5	S	M			L									M	

Unit 1: Matrices

Symmetric, skew-symmetric and orthogonal matrices; Determinants; Eigenvalues and eigenvectors; Cayley-Hamilton Theorem - Diagonalization of matrices - Orthogonal transformation- Reduction of Quadratic form to Canonical form.

Unit II: Vector Space

Vector Space - dimensions - linear combinations and span, spanning a vector space – Linearly Independent and dependent space - Subspace and Null –Space - Problems based on the above topics.

Unit III: One Variable Calculus

Rolle's Theorem- Mean value theorems - Taylor's and Maclaurin theorems with remainders - - Maxima and minima.

Unit IV: Two Variable Calculus

Limit, continuity and partial derivatives - total derivative - Maxima, minima and saddle points - Method of Lagrange multipliers.

Unit V: Simple Applications of One Variable Calculus

Curvature (Cartesian coordinates) - Evolutes and involutes; Evaluation of definite and improper integrals; Beta and Gamma functions and their properties.

TEXT BOOKS:

1. Grewal, B.S., Higher Engineering Mathematics, Khanna Publishers, New Delhi, 43rd Edition, 2015.
2. Kreyszig, E, Advanced Engineering Mathematics, John Wiley and Sons (Asia) Limited, Singapore, 10th Edition., 2001

REFERENCE BOOKS:

1. Ramana B. V., Engineering Mathematics, Tata McGraw-Hill Publishing Company Limited, New Delhi, Edition 2005.
2. Veerarajan,T., Engineering Mathematics (For First Year), Tata McGraw-Hill publishing company Limited, 2008.

211MEC1201	INTRODUCTION TO ENGINEERING VISUALIZATION	L	T	P	X	C
		0	0	2	3	2

Course Objective(s):

This course aims to introduce the concept of graphic visualization, develop the product design for communicating concepts, ideas and designs of engineering products, demonstrate skills in interpreting, and producing engineering drawings accurately and to give exposure to national standards relating to engineering drawing

Course Outcome(s):

After completing this course, the student will be able to:

CO1: Draw freehand sketch of 2D and 3D models through visual observation
CO2: Construct the geometric models of various solids and surfaces
CO3: Illustrate the solid intersections and their new surfaces
CO4: Construct the sheet metal models for various engineering components
CO5: Create perspective visual models for designed products

Mapping of Course Outcome(s):

CO / PO	PO												PSO		
	1	2	3	4	5	6	7	8	9	10	11	12	1	2	3
CO1	M		M											M	
CO2		H										L		M	
CO3	H		H		H		H					M		M	
CO4	L	M			H		H					H		M	
CO5	H		H		H		H					H		M	

Week	Practical
1	Drawing and its Standards
2	Brainstorming session by comparing the industrial standards.
3	Understanding and generating 3D drawing of disc
5	Formation of 3D drawing of Wheels
6	Geometrical and analytical model of point
7	Geometrical model of projecting a Line by manual parallel projection
8	Geometrical model of projecting a plane by manual parallel projection
9	Geometrical and analytical model of various regular solids - projecting a plane by manual parallel projection
10	Geometrical and analytical model of various irregular solids - projecting a plane by manual parallel projection
11	Construction and developing and curvilinear developed surface
12	Construction and developing and rectilinear developed surface
13	Combination of surfaces
14	Axonometric projection of base plate
15	Projection of tyre by perceptive method

X - Component:

Week	Practical
1	Free Hand Sketching on Selected Models – Layout Drawing
2	Applying and modifying the drawing on 3D sketch
3	Applying parallel projection to prepare 2D layout as per ANSI
5	Applying parallel projection to prepare 2D layout as per ANSI
6	Finding the distance between stars by the geometrical and analytical method. Finding the distance and space between two ICs arranged in stack with CAD packages
7	Finding the distance between two electrical poles by using standard CAD comments and by adopting the principles of parallel projection.
8	Finding the centre of gravity of the plane by geometrical approach and by CAD Packages which are located in different angle.
9	Finding the position and centre of gravity of the regular solids by geometrical approach and by CAD packages which are located in different angle.
10	Finding the position and centre of gravity of the regular solids by geometrical approach and by CAD packages which are located in different angle.
11	Generation of curvilinear surface for car bodies using CAD packages and finding the physical properties.
12	Generation of rectilinear surface for car bodies using CAD packages and finding the physical properties.
13	Generation of curvilinear and rectilinear surface for car bodies using CAD packages and finding the physical properties.
14	Generation of 2D and 3D sketching with layout using aforementioned solids
15	3D model of tyre by applying parallel and perceptive projection method using CAD

References:

S. No	Details
1	Natarajan, K.V., A Textbook of Engineering Graphics, 21st Edition, Dhanalakshmi Publishers, Chennai, 2012.
	Web-link: http://booksdelivery.com/n-dhanalakshmi-publications
2	Paul Richard, Jim Fitzgerald., Introduction to AutoCAD 2017: A Modern Perspective, Pearson, 2016.
	Web-link: https://www.pearson.com/us/higher-education/program/Richard-Introduction-to-Auto-CAD-2017-A-Modern-Perspective/PGM334072.html

211CSE1401	PROBLEM SOLVING USING COMPUTER PROGRAMMING	L	T	P	X	C
		1	0	2	3	3

Course Objective:

- To introduce the students with the foundations of computing, programming and problem-solving
- To make the students understand the concept of data representation in computers
- To make the students solve simple and complex problems through programming Concepts

Course Outcome(S):

CO1: Understand and formulate algorithms and pseudocode for problems
CO2: Able to represent, organize, manipulate and interpret data
CO3: Apply programming skills to implement pseudocodes and algorithms
CO4: Analyse and use decomposition techniques to simplify complex problems
CO5: Apply programming techniques to permanently store and retrieve large datasets for the problems.

Mapping of Course Outcomes:

CO / PO	PO												PSO		
	1	2	3	4	5	6	7	8	9	10	11	12	1	2	3
CO1	S											L	M	M	
CO2		S											M	M	
CO3	S											L	M	M	
CO4		L											M	M	
CO5	S	M			L								M	M	L

UNIT –I
Problem Solving - Pillars of Problem Solving - Analysing and representing Algorithms – Flowcharts - Importance of programming in problem solving - Expressing Algorithms in Pseudocode - Case studies in the specific domain of study in analysing and representing algorithms

UNIT –II
Computational thinking – Information to Data Format – Data Encoding – Binary Conversions and Binary Logic - Representation of Problem data in computer format - Introducing compiler, compiler features and, working with basic datatypes - working with DMA, creating strings using DMA concepts

UNIT –III
Writing Problem Workflow in Computer Language – Use control structures to write simple algorithms for sort, search and similar algorithms – Organizing multiple datasets in problem domain to computer format – Working with Single dimensional, multidimensional arrays, Use arrays to store string

UNIT - IV

Decomposing complex problems to simple solutions - functions – parameter passing – recursion - Organizing complex and variable datasets – Structures – Unions – Applications

UNIT - V

Representing and organizing large problem dataset – Files – Types - Modes - File operations - Applications

TEXT BOOKS

1. David D. Riley and Kenny A. Hunt, Computational Thinking for the Modern Problem Solver, CRC Press, 2014.
2. Pradip Dey and Manas Ghosh, Programming in C, Oxford University, Press, Third Edition, 2018.
3. Byron Gottfried, Schaum's Outline of Programming with C, McGraw-Hill, Third Edition, 2010

REFERENCE BOOKS

1. Brian W. Kernighan and Dennis M. Ritchie, The C Programming Language, PrenticeHall of India, Second Edition 1988
2. E. Balaguruswamy, Programming in ANSI C, Tata McGraw-Hill, Seventh Edition, 2017

211BIT1101	BIOLOGY FOR ENGINEERS	L	T	P	C
		3	0	0	3

Course Outcomes (s):

Upon successful completion of this course, students will be able to

CO1: Describe the fundamentals of cell structure and cell cycle
CO2: Understand the classification and functions of biomolecules
CO3: Describe the underlying concepts of infection and immunity
CO4: Explain the various applications of biology
CO5: Elaborate the role of biology in the development of next generation technology

Mapping of Course Outcomes:

CO / PO	PO												PSO		
	1	2	3	4	5	6	7	8	9	10	11	12	1	2	3
CO1	M	M		M		H							H	H	
CO2	H	M		H		M							H	M	
CO3	H			H		M							M	M	
CO4	H	M		H		H							M	M	
CO5	H	M		M									H	H	

Unit I: INTRODUCTION

Science and Engineering- Why should engineers know biology? Major discoveries in biology- Cell: basic unit of life- prokaryotes and eukaryotes- Cell structure, organelles and their functions, comparison of plant and animal cells- Overview of cell cycle and cell division

Unit II: BIOCHEMISTRY AND MOLECULAR ASPECTS OF LIFE

Biomolecules: Carbohydrates, Lipids, Vitamins, Proteins, Enzymes and how enzymes functions with one typical example; Glycolysis pathway. Nucleic acids: Genes, Genome and Chromosome - DNA as genetic material – Replication, Transcription, Genetic code, Translation.

Unit III: MICROORGANISMS AND INFECTION

Microorganisms- History of microbiology, Major classification of microbes-Cultivation of bacteria-Microscopy - Microbes as infectious agents - typhoid, tuberculosis, candida, malaria, hepatitis, polio, dengue, AIDS, SARS -Immunity to infection- innate and acquired immunity - organs and cells of the immune system - classification of antibodies - types of T cells – activation of B and T cells.

Unit IV: BIOLOGY AND ITS INDUSTRIAL APPLICATIONS

Basics of fermentation- Probiotics- Enzymes- Biofertilizers- Biomaterials - Bioenergy- Waste Water Treatment-Role of Genetic Engineering: insulin – Biopharming - Antibiotics, Vaccines, Monoclonal Antibodies- Stem Cell Technology - Self healing concrete

Unit V: INTERDISCIPLINARY TECHNOLOGIES INSPIRED FROM BIOLOGY

Role of biology in the development of next generation technology - Bio Inspired Inventions- Digital Camera - Eye comparison, Kingfisher - Bullet trains; Bird - Aircraft comparison - Artificial immune system and swarm robotics - 3D bio-printing: Cardiovascular, Respiratory, Renal system; Biochip, Muscular System - Bio-robotics, Sensory organs: electronic nose, electronic tongue, electronic skin - Nervous System: Artificial Neural Networks, Biosensors, Bioinformatics, Biophilic Design

Text Books:

1. Gabi Nindl Waite, Lee Waite, Applied Cell and Molecular Biology for Engineers, McGraw-Hill Education, 2007.
2. Arthur T. Johnson, Biology for Engineers, Second Edition, CRC Press, 2019.

Reference Books:

1. Michael Chappell, Stephen Payne, Physiology for Engineers - Applying Engineering Methods to Physiological Systems, Springer International Publishing, 2016.
2. W. Mark Saltzman, Biomedical Engineering: Bridging Medicine and Technology, Cambridge University Press, 2009.

211EEE1301	BASIC ELECTRICAL AND ELECTRONICS ENGINEERING	L	T	P	X	C
		3	0	2	0	4

Course Outcomes (CO)

On successful completion of the course, the students would be able to;

CO1: Apply the basic laws of electricity in DC and AC circuits
CO2: Understand the construction and operation of static and rotating electrical machines
CO3: Understand the constructional features and operation of fundamental electronic devices and circuits
CO4: Understand the characteristics of digital electronics
CO5: Understand the functioning of digital measuring instruments, sensors and transducers

Mapping of Course Outcomes:

CO / PO	PO												PSO		
	1	2	3	4	5	6	7	8	9	10	11	12	1	2	3
CO1	M	M		M	M	L		L	M	L			M		
CO2	M	M		M	M	L		M	L	M			M		
CO3	M			M	M	L		L	M	L			S		
CO4	S	M											M		
CO5	S	S	L	M	M	L	M	M	L	M			M		

UNIT I: Electric Circuits

Circuit elements – resistor, inductor, capacitor - Ohm's Law - Kirchhoff's Laws - series and parallel circuits - analysis of DC circuits - mesh, nodal analysis – simple problems. Alternating voltage - RMS and Average values - form and peak factors - Single phase AC circuits - power, energy calculation and power factor - Concept of three phase system.

UNIT II: Electrical Machines

Construction and operation of DC machines – DC generator – DC motor. Single phase transformer – Construction and operation. Alternator, Three phase induction motor – Construction and operation – Types. Single phase induction motor – Construction – Working – Capacitor start and capacitor run motor.

UNIT III: Electronic Devices and Circuits

PN junction diode, BJT, FET, MOSFET – Working & Characteristics, Diode based half wave and full wave rectifier – Transistor as switch. Applications of Electronic Circuits.

UNIT IV: Digital Electronics

Boolean Algebra - Simplification of Boolean Expressions - Logic Gates - Implementation Of Combinational Logic Circuits – Half Adder, Full Adder, Parallel Adder, Encoders, Decoders – Multiplexers, De- Multiplexers. Applications of Digital Electronic Circuits.

UNIT VI: Transducers and Digital Instruments

Sensors & Transducers - selection criteria – LVDT, Tachogenerator, Passive Infrared (PIR), LM35, LDR – Working principle, Applications – Transmission of transducer signal outputs (V, I, F) – Concept of Digital Instruments.

Text Book(s):

1. V.K. Mehta, "Principles of Electrical Engineering and Electronics", S. Chand & Company Ltd,2012
2. S. K. Bhattacharya, Basic Electrical and Electronics Engineering, Pearson, 2016.
3. Albert Malvino, David J. Bates, "Electronic Principles", 7th Edition, McGraw Hill Education;2017.
4. Electronic devices and circuit theory / Robert L. Boylestad, Louis Nashelsky.—11th edition,Pearson Education Inc.

Reference(s):

1. R. Muthususbramanian and S. Salivahanan, "Basic Electrical, Electronics and Engineering"McGraw Hill Education (India) Private Limited, 2013.
2. T. Thyagarajan, "Fundamentals of Electrical and Electronics engineering", SciTech publications (Ind.) Pvt. Ltd., 3rd Edition, 2015.

211CHY1301	CHEMISTRY	L	T	P	X	C
		3	0	2	0	4

Course Outcomes (CO)

On successful completion of the course, the students would be able to

CO1: Analysing the structure and bonding in molecules from quantum level
CO2: Interpreting the spectral data of unknown substances
CO3: Evaluating the corrosion behaviour of metals and characteristics of water
CO4: Examining the behaviour of various atoms according to their position in periodic table.
CO5: Relating the stereochemistry of the substances with chemical reactions.

Mapping of Course Outcomes:

CO / PO	PO												PSO		
	1	2	3	4	5	6	7	8	9	10	11	12	1	2	3
CO1	M	M		M	M	L		L	M	L			M		
CO2	M	M		M	M	L		M	L	M			M		
CO3	M			M	M	L		L	M	L			S		
CO4	S	M											M		
CO5	S	S	L	M	M	L	M	M	L	M			M		

UNIT 1: Atomic and molecular structure

Wave-particle duality of electrons. Schrodinger equation. Forms of the hydrogen atom wave functions and the plots of these functions to explore their spatial variations (s, p and d). Molecular orbitals of diatomic molecules (Hydrogen, nitrogen, oxygen, carbon monoxide and

nitric oxide) and plots of the multicentre orbitals. Equations for atomic and molecular orbitals. Crystal field theory and the energy level diagrams for transition metal ions (iron and Ni) and their magnetic properties.

UNIT II: Spectroscopic techniques

Principles of spectroscopy and selection rules. Electronic spectroscopy (Instrumentation and working). Fluorescence (Instrumentation and working) and its applications. IR spectroscopy: Instrumentation, working and applications.

UNIT III: Equilibrium Thermodynamics and water chemistry

Thermodynamic functions: Work, heat, enthalpy, entropy and free energy. Free energy and EMF. Electrode potentials. Nernst equation and applications. Acid-base, oxidation-reduction and solubility equilibria. Corrosion: Dry and wet corrosion – mechanism and corrosion control (Sacrificial anode and impressed current cathodic protection). Estimation of hardness of water and chloride ion.

UNIT IV: Periodic properties and molecular interactions

Electronic configurations - Effective nuclear charge and its significance. Periodic properties: Atomic and ionic sizes, ionization energies, electron affinity and electronegativity. Hard and soft acids and bases. Ionic, dipolar and van der Waals interactions.

UNIT VI: Stereochemistry and reaction mechanism

Representations of 3-D structures, structural isomers and stereoisomers, configurations. Symmetry and chirality, enantiomers, diastereomers, optical activity, absolute configurations and conformational analysis of alkanes (up to 4 carbons). Geometrical isomerism in alkenes. Introduction to reactions involving substitution (SN1, SN2, SNi, SNAr, benzyne, halogenation, sulphonation, nitration, Friedel Crafts alkylation and acylation), addition (Electrophilic and nucleophilic), elimination (E1 and E2). Synthesis (conventional and green routes) of commonly used drug molecules (aspirin and ibuprofen).

LIST OF EXPERIEMENTS:

1. Determination of Fe (III) ion in the given complex by spectrophotometric method
2. Preparation of tetrammine copper (II) sulphate
3. Verification of Lambert Beer's law: Estimation of $KMnO_4$
4. Preparation of Mohr Salt
5. Estimation of iron content in drug / alloy / ore
6. Determination of EMF of a cell
7. Determination of hardness of water sample
8. Determination of halide ion concentration in the given water sample
9. Potentiometric Redox titrations
10. Potentiometric Acid-Base titrations
11. Potentiometric precipitation titrations
12. Thin layer chromatography
13. Determination of surface tension
14. Determination of viscosity
15. Synthesis of a polymer / drug (Bakelite / Urea-formaldehyde / Aspirin)

Reference books:

1. University Chemistry, Bruce M. Mahan and Rollie J. Meyers, 4th edition, Pearson EducationIndia (2009).
2. Engineering Chemistry, P.C. Jain and Monika Jain, 17th edition, Dhanpat Rai PublishingCompany Ltd (New Delhi) (2015).
3. Fundamentals of Molecular Spectroscopy, Colin N. Banwell and Elaine McCash, 4th edition,McGraw Hill (India) Private Limited (2016).
4. Organic Chemistry: Structure and Function, K. P. C. Volhardt and N. E. Schore, 5th edition,
5. W. H. Freeman; 6th edition (2010).
6. Organic Chemistry: A mechanistic approach, Tadashi Okuyama and Howard Maskill, Oxford University Press (2014).
7. Essentials of Physical Chemistry, Arun Bahl, B.S. Bahl and G. D. Tuli, 28th edition, S. Chand Publishing Company (2010).
8. Principles of Physical Chemistry, B. R. Puri, Madan S. Pathania and L. R. Sharma, 47thedition, Vishal Publishing Company (2020).
9. Reactions, Rearrangements and Reagents, S.N. Sanyal, 4th edition, Bharati Bhawan Publishers & Distributors (2019).

211MEC1401	SUSTAINABLE DESIGN AND MANUFACTURING	L	T	P	X	C
		1	0	2	3	3

Course Objective(s):

- To gain knowledge about the tools and techniques for sustainable design.
- To select the material, equipment, and development of a product.
- To adopt various software tools, process, and techniques for digital manufacturing.
- To apply these techniques into various applications.

Course Outcome(s):

After completing this course, the student will be able to:

CO1: Able to apply the sustainable design practices to improve the existing product.
CO2: Able to perform design analysis
CO3: Perform optimization on design and materials selections
CO4: Capable to prepare process layouts for the optimized products
CO5: Choose appropriate method of manufacturing the products

Mapping of Course Outcome(s):

CO/ PO	PO												PSO		
	1	2	3	4	5	6	7	8	9	10	11	12	1	2	3
CO1	2		2										1	1	
CO2		3										1	1	1	
CO3	2		3		3		3					2	3	2	3
CO4	1	2			3		3					3	3	2	3
CO5	3		3		3		3					3	3	2	3

Practical Component:

Week	Practical
1	Mechanical operations-based case study selection and factors demonstration
2	Discipline based case study selection and factors demonstration
3	Inter-disciplinary case study selection and factors demonstration
5	Brainstorming on need analysis on selected products/process
6	Preparing the free-parametric models – manual mode
7	Performing design optimization and decision making through software tools
8	Creating sketching and detailing for the optimum model
9	Meshing and perform numerical analysis on the model
10	Manufacturing process identification and detailing
11	Sustainability assessment and presentation on various factors
12	Job order preparation and logistic strategies
13	Possible prototyping and manufacturing
14	Reporting and documentation
15	Final presentation

X - Component:

Week	Practical
1	Introduction to “Altair Inspire” or equivalent platform – tools study and apply
2	Introduction to Finite Element Analysis (FEA) – practice to do numerical models
3	Industrial example reconstruction via CAE tools
5	Parametric modeling with dimensioning and tolerancing
6	Hands-on-practice on optimization tools like mini-tab etc.,
7	Planning and preparing Bill-of-materials mass and cost estimations
8	Brainstorming on prepared BOM and related items
9	Brainstorming on prepared BOM and related items
10	FEA model brainstorming and optimize the final model
11	Manufacturing process layout and factor presentation
12	Manufacturing process layout and factor presentation
13	Hands-on-session on modern tools on reporting and documentations
14	Product demonstration and defending sustainability suitability
15	Product demonstration and defending sustainability suitability

References:

S. No	Details
1	Introduction to Sustainability for Engineers by Toolseeram Ramjeawon 2020 by Taylor & Francis Group, LLC, ISBN: 978-0-367-25445-2
	ISBN 9780429287855 (ebook): https://lccn.loc.gov/2019042493
2	Introduction to Sustainability Road to a Better Future by Nolberto Munier ISBN-10 1-4020-3558-6 (e-book) Springer, New York
	https://greenco.in/index.php - for case studies

211MAT1303	MULTIPLE INTEGRATION, ORDINARY DIFFERENTIAL EQUATIONS AND COMPLEX VARIABLES	L	T	P	X	C
		3	0	2	0	4

Course Objective

To enable the students to understand the concepts of multiple integrations and their application, vector calculus, to solve ordinary differential equations and compute the residue of a function and use the residue theory to evaluate a contour integral or an integral over the real line.

Course Outcomes

Upon successful completion of this course, students will be able to

CO1: Know the methods of solving differential equations of first and second orders.

CO2: Understand the concepts of double and triple integral and its applications.

CO3: Know about the applications of double and triple integral in vector calculus.

CO4: Apply the concept and consequences of analyticity and the Cauchy-Riemann equations and of results on harmonic and entire functions including the fundamental theorem of algebra.

CO5: Evaluate complex contour integrals directly and apply the Cauchy integral theorem in its various versions, and the Cauchy integral formula.

Mapping of Course Outcome(s):

CO/ PO	PO												PSO		
	1	2	3	4	5	6	7	8	9	10	11	12	1	2	3
CO1	S											S		M	
CO2				M							S			M	
CO3	S													M	
CO4			S											M	
CO5		S										M		L	

Unit 1: Ordinary differential equations

Exact, linear and Bernoulli's equations, Euler's equations, Equations not of first degree: equations solvable for p and Clairaut's type. Second order linear differential equations with constant coefficients and variable coefficients, method of variation of parameters.

Unit II: Multiple Integration

Double integrals (Cartesian), change of order of integration in double integrals, change of variables (Cartesian to polar), Areas; Triple integrals (Cartesian), and Volume, Applications involving cubes, sphere and rectangular parallelepipeds.

Unit III: Vector Calculus

Gradient, curl and divergence. Scalar line integrals, vector line integrals, scalar surface integrals, vector surface integrals, Theorems of Green, Gauss and Stokes.

Unit IV: Complex Variable

Differentiation, Cauchy-Riemann equations, analytic functions, Construction of analytic functions, harmonic functions; elementary analytic functions (exponential, trigonometric, logarithm) and their properties; Conformal mappings, Mobius transformations and their properties.

Unit V: Complex Integration

Contour integrals, Cauchy's Integral theorem, Cauchy Integral formula (without proof); Taylor's series, zeros of analytic functions, singularities, Laurent's series; Residues, Cauchy Residue theorem (without proof), Evaluation of definite integral involving sine and cosine, Evaluation of certain improper integrals (Integration around circles and semicircles).

TEXT BOOKS:

1. Grewal, B.S., Grewal, J.S., Higher Engineering Mathematics, Khanna Publishers, New Delhi, 43rd Edition, 2015.

REFERENCE BOOKS:

1. Kreyszig, E, Advanced Engineering Mathematics, John Wiley and Sons (Asia) Limited, Singapore, 10th Edn., 2001.
2. Ramana B. V., Engineering Mathematics, Tata McGraw-Hill Publishing Company Limited, New Delhi, Edition 2005.
3. Veerarajan,T., Engineering Mathematics (For First Year), Tata McGraw-Hill publishing company Limited, 2008.

211MAT1302	STATISTICS FOR ENGINEERS	L	T	P	X	C
		3	0	0	3	4

Course Objective

To enable the students to understand the basic concepts of statistical techniques, analyze statistical data graphically, solving real world problems using testing of hypothesis and design of experiment translate the real world problem in to probability models and derive the probability density function of transformation of random variables.

Course Outcomes

Upon successful completion of this course, students will be able to

CO1: Analyze the statistical data using measures of central tendency, dispersion and location.
CO2: Analyze the statistical data using testing of hypothesis.

CO3: Know about the one way and two way classifications of statistical data, C.R.D, R.B.D and L.S.D

CO4: Examined statistical problems by means of probability theory which is using in all the fields of scientific experimentation and distributions.

CO5: Derive the probability density function of transformation of random variables.

Mapping of Course Outcome(s):

CO/ PO	PO												PSO		
	1	2	3	4	5	6	7	8	9	10	11	12	1	2	3
CO1	S			S								S		M	M
CO2				M							S			M	M
CO3		S									S			M	M
CO4			S							S				M	M
CO5	S			L										M	M

UNIT-I: INTRODUCTION TO STATISTICS

Definition of Statistics – Scope and Limitations of Statistics – Statistical investigation – Stages in conducting survey – Primary data vs Secondary data – Classification, Tabulation and presentation of data diagram (Simple problems on the above topics) - Arithmetic mean, Geometric mean, Harmonic mean, median and mode, Range, Variance and Standard deviation.

UNIT-II: TESTING OF HYPOTHESIS

Sampling distributions – Statistical hypothesis – Large sample tests based on Normal distribution for single proportion, difference of proportions, single mean and difference of means, Small sample tests- Student's t-distribution (single mean, difference of means) - F-distribution - Chi-square distribution (Goodness of fit – independence of attributes).

UNIT III: DESIGN OF EXPERIMENTS

One way and Two-way classifications – Completely randomized design – Randomized block design – Latin square design.

UNIT-IV: ONE DIMENSIONAL RANDOM VARIABLES

Probability – The axioms of probability – Conditional probability – Baye's theorem – Discrete and continuous random variables –Binomial, Poisson, Exponential and Normal distributions.

UNIT-V: TWO DIMENSIONAL RANDOM VARIABLES

Joint and conditional probability; Correlation and regression analysis, functions of one and two random variables.

TEXT BOOK(S)

1. T. Veerarajan, Probability, Statistics and Random process, Fourth edition, Tata McGraw-Hill Education (India) Pvt. Ltd., 2016.

2. A.M. Goon. M.K.Gupta and B.Dasgupta – Fundamentals of Statistics. Vol. I & II.
3. Introduction to Probability and Statistics for Engineers and Scientists by S.M. Ross
4. Introduction to Probability Theory and Statistical Inference by H.J. Larson.
5. Kayathri Rajagopalan, A python Data Analyst's Toolkit, Apress, 2021.

REFERENCE BOOK(S)

1. S.C Gupta- Fundamental of statistics- Himalaya publishing house- 2014.
2. Thomas Haslwanter, An Introduction to Statistics with Python, Springer, 2016.

211CSE1402	PYTHON PROGRAMMING	L	T	P	X	C
		1	0	2	3	3

COURSE OBJECTIVES:

- To learn how to use lists, tuples, and dictionaries in Python programs.
- To learn how to identify Python object types.
- To learn how to use indexing and slicing to access data in Python programs.
- To define the structure and components of a Python program.
- To learn how to write loops and decision statements in Python.
- To learn how to write functions and pass arguments in Python.
- To learn how to build Python modules for reusability.
- To learn how to read and write files in Python.
- To learn how to design object-oriented programs with Python classes.
- To practice data processing, analysis and visualization with python

COURSE OUTCOMES:

CO1: Understand the constructs and concepts of a programming language
CO2: Apply Python data structures for problem solving and programming
CO3: Implement user defined python functions and build an efficient program leveraging modules
CO4: Create python programs to handle file I/O and exceptions, and solve problems with Object Oriented Concepts
CO5: Understand Data processing, Validation, Visualization concepts in python with regex, pandas, matplotlib and numpy packages.

Mapping of Course Outcome(s):

CO/ PO	PO												PSO		
	1	2	3	4	5	6	7	8	9	10	11	12	1	2	3
CO1	S	S	L	M			M		L	S	S	S	S	L	
CO2	S	S	S	S			M		M	S	S	S	S	L	
CO3	S	S	S	S			M		M	S	S	S	S	M	
CO4	S	S	S	S	S		M	L	M	S	S	S	S	M	
CO5	S	S	S	S	S	L	M	L	S	S	S	S	S	M	

UNIT I: Getting Started with Programming

Introduction, Python Versions, Applications of Python in mainstream technologies. Strings and Formatting: Basic Syntax, Comments, String Values, String Methods, The format Method, String Operators, Numeric Data Types, Conversion Functions, Simple Output, Simple Input, The % Method, The print Function Language Components: Indenting Requirements, the if Statement, Relational and Logical Operators, Bit Wise Operators, the while Loop, break and continue, The for Loop.

UNIT II: Python Data Structures

Introduction to Python Data Structures, Lists, Tuples, List Comprehensions, Nested List Comprehensions, Sets, Dictionaries, Sorting Dictionaries, Copying Collections, Dictionary Comprehensions, Dictionaries with Compound Values

UNIT III: Functions and Modules

Functions: Introduction, Defining Your Own Functions, Parameters, Function Documentation, Keyword and Optional Parameters, Passing Collections to a Function, Variable Number of Arguments, Scope, Functions - ”First Class Citizens”, Passing Functions to a Function, map, filter, Mapping Functions in a Dictionary, Lambda, Inner Functions, Closures
Modules: Modules, Standard Modules – sys, math, time, The dir Function

UNIT IV: Exceptions, I/O and OOP

Exceptions: Errors, Runtime Errors, The Exception Model, Exception Hierarchy, Handling Multiple Exceptions, raise, assert.
Input and Output: Introduction, Data Streams, Creating Your Own Data Streams, Access Modes, Writing Data to a File, Reading Data from a File
Object Oriented Programming: Class Coding Basics Class Statement Methods Inheritance Attribute Tree Construction Specializing Inherited Methods Class Interface Techniques Abstract Super Classes

UNIT V: Data Processing, Analysis and Visualization

Regular Expressions: Introduction, Simple Character Matches, Special Characters, Character Classes, Quantifiers, The Dot Character, Greedy Matches, Grouping, Matching at Beginning or End, Match Objects, Substituting, Splitting a String, Compiling Regular Expressions, Flags.
Numerical Analysis & Plotting: Numpy – Overview, Setup, Datatypes, Basic Operators, Indexing, Broadcasting, Matrix Operators. Matplotlib-Overview, Setup, Basic plots, Customizing plots, Subplots, 3D plots.
Data Processing with Pandas: Pandas – Overview, Setup, Data Structures, Indexing & Selecting Data, group by Operations, Reshaping data.

X Component

- **Competitive coding using Core Python** – Practical Assignments and Hackerrank challenges
- **GUI Development using Python** – Project

TEXT BOOK(S):

1. Mark Lutz, “Learning Python”, Fifth Edition, O’Reilly, 2018

REFERENCES:

1. Charles Severance, 2016, Python for everybody: exploring data in Python 3
2. Charles Dierbach, 2013, Introduction to Computer Science using Python: a computational problem-solving focus, Wiley Publishers

211ECE1400	IoT - SENSORS AND DEVICES	L	T	X	C
		1	0	3	2

Course Outcomes:

After completing this course, the student will be able to:

CO1: Understand the working of basic electronic components and Sensors.
CO2: Understand the advantages of the different types of Arduino Microcontrollers.
CO3: Apply the knowledge of PWM and Serial communication in different circuits.
CO4: Understand the working of Wi-Fi module and different protocols for communication for usage in IoT.
CO5: Apply the Sensors by building circuits for the given requirements.
CO6: Work effectively in as team and individual in doing the experiments following the safety procedures and ethics and document effectively the experiments carried out in the laboratory.

Mapping of Course Outcome(s):

CO/ PO	PO												PSO		
	1	2	3	4	5	6	7	8	9	10	11	12	1	2	3
CO1	M				L										L
CO2	L	L			M		L					M			L
CO3	M				L										L
CO4	M	M	L		M		M					M			L
CO5	L	M	M	L	M	L	M					L			L
CO6								M	M	M					L

Unit 1 Sensors for IoT
Active and Passive Sensors, Different Types of Sensors such as Capacitive, Resistive, and Surface Acoustic Wave Sensors for Pressure, Humidity, Toxic Gas; Sensors for Water (pH) quality, Accelerometer, Gyroscope, Moisture, Hall effect and Humidity.

Unit 2 Microcontroller
Introduction to microcontrollers and microprocessors, Different microcontrollers, Arduino: Types, UNO Architecture, ADC, DAC, Data acquisition.

Unit 3 Arduino Programming
Digital Pins as Input and Output, Reading Analog Quantities, PWM Pin- Arduino's Serial Port and Serial Communication. Interfacing of DC Motor and Relay

Unit 4 IoT System
Basics of IoT, IoT Levels, Things and Connections, Building Blocks of IoT connectivity (Client- Server, Web Interface, and API: Qualitative Analysis only), Protocols and Communication (Zigbee, Bluetooth, Wi-Fi, MQTT: Qualitative Analysis only), Bluetooth and Wi-Fi Modules for Arduino.

Unit 5 IoT Applications
Application of IoT in the industry, buildings, smart city, logistics, environment, health care, agriculture, and lifestyle products

X-Component Topics:

1. Building basic circuit diagrams using breadboard and Working of a Multimeter.
2. Simple circuit using IC on breadboard.
3. Simple Relay circuit design for ON-OFF condition.
4. Switch on an LED if a button is pressed.
5. Changing brightness of LED using potentiometer.
6. Change the brightness of LED (Fade in/ Fade out) using PWM.
7. DC motor speed control using serial communication.
8. Interfacing Wi-Fi module with Arduino.
9. Sending information about the patient in home to the doctor's PC/mobile.
10. Design a simple circuit to measure the pH value of wastewater.
11. Design a simple circuit to maintain the CO2 level inside the room.
12. Design a simple circuit to apply Hall-effect sensor.

Theory:

1. Peter Dalmaris, "Basic Electronics for Arduino Makers", Packt Publishing, 2017.
2. Tim Pulver, "Hands-On Internet of Things with MQTT: Build Connected IoT Devices with Arduino and MQ Telemetry Transport (MQTT)", Packt Publishing, 2019.
3. Marco Schwartz, "Internet of Things with Arduino Cookbook", Packt Publishing, 2016.

Reference(s):

1. Jody Culkin, Eric Hagan, "Learn Electronics with Arduino: An Illustrated Beginner's Guide to Physical Computing" Make Community, LLC, 2017.
2. Michael Margolis, "Arduino Cookbook" O'Reilly, 2011.
3. Julien Bayle, "C Programming for Arduino", Packt Publishing Ltd., 2013.

Other References:

1. https://www.edx.org/course/iot-sensors-and-devices
2. https://www.coursera.org/learn/internet-of-things-sensing-actuation
3. https://www.naukri.com/learning/iot-sensors-and-devices-course-edxl593
4. https://online.stanford.edu/courses/xee100-introduction-internet-things

PROGRAMME CORE COURSES

212BIT1301	MICROBIOLOGY	L	T	P	X	C
		3	0	2	0	4

Course objective(s):

To provide basic understanding of microorganisms, its classification, structure and functions of microorganisms, physiology, genetics, pathology and ecology

Course Outcomes (COs):

At the end of the course, students would be able to

1. Describe diversity, classification and identification methods of microorganisms.
2. Explain the structure and function of bacteria, viruses, fungi, algae, yeast etc.
3. Explain the cultivation of bacteria and basic genetics of bacteria
4. Discuss the association between microorganisms and diseases, pathogen interaction with the host, identification and application of antibiotics.
5. Demonstrate the knowledge as to how microorganisms interact with their environment and interaction between humans and microorganisms.

Mapping of Course Outcomes:

CO / PO/PSO	PO												PSO		
	1	2	3	4	5	6	7	8	9	10	11	12	1	2	3
CO1	H	H	M	H	H			H	H					H	
CO2		H		H	H			H	H			H		M	
CO3		H	H	H				H						H	
CO4	H	H	H		H			H	H				H	H	
CO5						H		H		H	H	H		H	M

Unit 1: Microbial Classification **9 hours**

Basics and History of microbiology- Evolution of microbiology, Classification and Nomenclature of microorganisms. Type cultures and culture collections. Microscopy - Principles and applications of Light, Dark field Microscopy, Phase contrast microscopy, Fluorescent microscopy, Electron microscope- TEM & SEM. Staining Techniques – Simple staining and Differential staining – Gram's staining, Acid-fast staining, Spore, capsular and flagellar staining. Pure culture techniques.

Unit 2: Physiology of microorganisms **9 hours**

Bacteria - General Characteristics, Morphology - Structure of the bacterial cell wall, Appendages of bacteria - pili and flagella, capsule, slime layer, endospores and mode of reproduction. Virus – General Characteristics, Structure and classification. Bacteriophages – Structure and Life cycle - T4, Lambda and M13. Algae and fungi - General Characteristics, Structure, classification and multiplication. Life cycle of Yeast

Unit 3: Cultivation of Bacteria and Genetics **9 hours**

Nutritional requirements of bacteria, Cultivation of bacteria – Types of media – Differential, selective, enriched, enrichment. Bacterial growth curve - Measurement, kinetics and generation time. Bacterial growth under aerobic and anaerobic conditions. Bacterial reproduction - binary fission, Transformation, Conjugation and transduction. Mutation and recombination.

Unit 4: Microbial Pathology **9 hours**

Microorganisms as pathogens. Common infectious diseases. Disease caused by Bacteria – *Salmonella typhi*, *Streptococci*, *Mycobacterium tuberculosis*, Virus - Hepatitis, HIV, SARS CoV. Fungi, Candida, Trichophytan. Parasites – Amoeba, Plasmodium, Worm - Ascaris. Common antibiotics and its classification.

Unit 5: Microbial Ecology **9 hours**

Effect of environmental factors on the growth of microorganisms. Microbial interactions and its types. Plant associated microorganisms - Rhizosphere, phylloplane micro flora, Mycorrhiza. Air and water micro flora. Host-Microbe interaction – Microbiota of health and Human Microbiome, Biogeochemical cycles – Nitrogen cycle, Phosphorous cycle.

Experiments **(45 Hours)**

1. Laboratory safety and sterilization Techniques (Lecture / Demonstration)
2. Pure culture techniques.
3. Microscopy
4. Simple staining, Gram's staining and Spore staining
5. Capsule staining and flagella staining.
6. Bacterial growth curve
7. Hanging drop technique for motility.
8. Growth in selective and differential media.
9. Biochemical tests - IMViC Tests.
10. Catalase, Oxidase test, Starch hydrolysis test
11. Effects of temperature and pH on bacterial growth.
12. Antibiotic disc sensitivity test.
13. Effect of disinfectants on microbial flora.
14. Isolation and identification of microorganisms from soil, Water and milk.

Text book (s)

1. Pelczar MJ, Chan ECS and Krieg NR - Microbiology - Tata McGraw Hill, India, 2010 (7^{th} Edition).
2. Prescott LM, Harley JP and Klein BA - Microbiology - Wm. C. Brown Publishers, IOWA. USA - 2008 (7^{th} Edition).

Reference (s)

1. Tortora GJ, Funke BR and Case CL - Microbiology: An Introduction Benjamin Cummings - Pearson - 2016 (12^{th} Edition).
2. Jeffrey C Pommerville - Jones Alcamo's Fundamentals of Microbiology - Bartlett Publishers -2011 (9^{th} edition).

212BIT1302	BIOCHEMISTRY	L	T	P	X	C
		3	0	2	0	4

Course objective(s)

To provide knowledge on basic concept of biomolecules and various metabolic pathways of biological systems

Course Outcomes

At the end of the course, students would be able to

CO1: Understanding the fundamental concepts of biomolecules and their biological functions

CO2: Explain the metabolism of carbohydrates and its importance in energy derivation.

CO3: Describe the importance of protein metabolism and its significance in energy flow.

CO4: Understand the role of lipid metabolism in assimilating energy.

CO5: Describe the role of nucleic acid metabolism and diseases associated with metabolic alternations.

Mapping of Course Outcomes:

CO / PO/ PSO	PO												PSO		
	1	2	3	4	5	6	7	8	9	10	11	12	1	2	3
CO1	H	M	M	M	M	M	H					M	H	H	
CO2	H		M			M						M			
CO3	H		M			M						M	M	M	
CO4	H		M			M						M			
CO5	H		M			M						M	H	H	

Unit 1: Introduction to Biomolecules & Bioenergetics 9 hours

Classification, structure and reactions of carbohydrates- Structural organization of proteins- primary, secondary, tertiary, quaternary structures. -Classifications of amino acids. Structure, properties and classification of lipids. High energy phosphate compounds- Requirements of ATP for synthesis and degradation cycle.

Unit 2: Carbohydrate Metabolism 9 hours

Glycolysis, TCA cycle and glyoxylate cycle - Mitochondrial shuttles - Pentose phosphate pathway, gluconeogenesis oxidative phosphorylation, electron transport chain, gluconeogenesis – Glycogenolysis. Case studies – Glycogen storage diseases.

Unit 3: Protein Metabolism 9 hours

Biosynthetic pathway of amino acids - amino acid degradative pathways - Urea cycle Different levels of regulation - Allosteric regulation - Reversible covalent modification, - Case studies- Inborn Metabolic error of amino acid metabolism

Unit 4: Lipid Metabolism **9 hours**

Fatty acids metabolism - β-oxidation pathway - Ketone bodies - Biosynthesis of fatty acids - Control of lipid metabolism – Case studies -Disorders of lipid metabolism.

Unit 5: Nucleic Acid Metabolism **9 hours**

Biosynthesis of purine nucleotides (adenine, guanine) - Biosynthesis of pyrimidine nucleotides (cytosine, thymine, and uracil) - Catabolism of adenine, guanine, cytosine, thymine, and uracil –Case studies- Metabolic disorders associated with purine and pyrimidine metabolism.

Experiments **(45 Hours)**

1. Preparation of buffers (acidic, basic, neutral, biological)
2. Titration curves for amino acid, determination of pKa and pI
3. Qualitative analysis of lipids, carbohydrates and amino acids
4. Estimation of amino acid by Ninhydrin method
5. Estimation of protein (Biuret and Lowry Method)
6. Estimation of total sugars by Anthrone method.
7. Estimation of total sugars by DNS method.
8. Estimation of aldose and ketose sugars
9. Estimation of cholesterol by ZAK'S method.
10. Determination of acid value, saponification value and iodine number of oils and fats Method

Text Books

1**.** Lehninger, Nelson and Cox - Principles of Biochemistry - W.H.Freeman & Company - 2021 (8^{th} Edition).

2. Sathyanarayana U - Biochemistry - Elsevier India - 2017 (5^{th} Edition).

References

1. Voet D and Voet JG - Fundamentals of Biochemistry - John Wiley & Sons, Inc -2019 (5^{th} Edition).
2. Stryer L - Biochemistry - W.H. Freeman and Company - 2019 (9^{th} Edition).
3. Murray RK, Granner DK, Mayes PA and Rodwell VW - Harper's Illustrated Biochemistry - McGraw-Hill Educaton - 2018 (31^{st} Edition).

212CHE1304	PRINCIPLES OF CHEMICAL ENGINEERING	L	T	P	X	C
		3	1	2	0	5

Course objective(s):

To impart the knowledge of chemical engineering principles pertaining to biotechnological applications.

Course Outcomes:

At the end of the course, students would be able to

CO1: Recognize the different units of measurements in basic chemical calculations and calculate the composition of solutions and gas mixtures.

CO2: Solve material balance of physical and chemical processes.

CO3: Explain the phenomena of fluid statics and dynamics and its applications.
CO4: Explain the principles of particle science, filtration and sedimentation.
CO5: Explain the mechanism of heat transfer and its application.

Mapping of Course Outcomes:

CO /	PO												PSO		
PO/PSO	1	2	3	4	5	6	7	8	9	10	11	12	1	2	3
CO1	H	M		M			L		L				H	H	M
CO2	H	M		M					M				H	H	M
CO3	H	M		M					M				H	H	M
CO4	H	M		M									H	H	M
CO5	H	M		M									H	H	M

Unit 1: INTRODUCTION TO ENGINEERING CALCULATIONS, UNITS AND DIMENSIONS 12 hours

Introduction – Units and dimensions, Fundamental and derived quantities, Unit conversions, stoichiometric principles; Basic chemical calculations – Composition of mixtures and solutions- Percentage by weight, mole and volume; normality, molarity, molality, and ppm. Gaseous mixtures - Ideal gas law and its application, Dalton law, Raoult's law, Henry's law.

Unit 2: MATERIAL BALANCES 12 hours

Material balance without chemical reactions: Three general methods of solving material balance problems, Material balance of unit operations like distillation, absorption, extraction, drying, crystallization, evaporation and mixing. Material balance with chemical reaction - definitions of limiting and excess reactants, fractions and percentage conversion, yield and percentage yield, Selectivity and related problems.

Unit 3: BASICS OF FLUID MECHANICS 12 hours

Properties of fluids, Newtonian and Non-newtonian fluids. Fluid statics – Barometric equation – application for incompressible and compressible fluids. pressure measurement, Dimensional analysis; Buckingham pi theorem - Equation of continuity and motion - Bernoulli's equation and its applications - Fluid flow measurement, Orifice, venture & Rotameter for Newtonian fluids. Principles and operation of variable head meter.

Unit 4: PARTICLE TECHNOLOGY 12 hours

Particle size reduction, screening & screen Effectiveness, Liquid Filtration and filters - Constant pressure and constant volume batch filtration, continuous filtration - Industrial filters - batch sedimentation test – Centrifugation.

Unit 5: HEAT TRANSFER 12 hours

Introduction – Conduction, Convection and Radiation – Steady state conduction - Combined resistances - conduction through composite walls - Unsteady state conduction - Combined conduction and convection –forced and free convection mechanism.

LIST OF EXPERIMENTS

1. Determination of cake resistance of filter medium using Leaf filter
2. Determination of cake resistance of filter medium using Rotary drum filter
3. Determination of discharge co- efficient using orifice meter
4. Determination of discharge co- efficient using venturimeter
5. Determination of effectiveness of screen
6. Determination of area of clarifier and thickener

7. Estimation of thermal conductivity of insulating powder
8. Verification of Rayleighs equation using simple distillation
9. Determination of leaching efficiency

Text Book (s):

1. Bhatt, B.I. and Vora, S.M. – Stoichiometry - Tata McGraw-Hill Publishing Company, New Delhi – 2004 (4^{th} Edition)
2. K.V.Narayanan and Lakshmikutty, Chemical Process Calculations, Prentice Hall, 2004.
3. McCabe W.L., Smith J.C. and HariottP,, "Unit Operation in Chemical Engineering" 7^{th}Edition,Tata McGraw – Hill, 2004.

Reference (s):

1. Himmelblau, D.M. - Basic Principles and Calculations in Chemical Engineering, Prentice-Hall of India, New Delhi – 2004 (7^{th} Edition)
2. Coulson J.M. and Richardson J.F., "Coulson and Richardson's Chemical Engineering" Vol-I 3^{rd} Edition,Butterwoth – Heinemann Publishers,2004.
3. R K Bansal, "*A Textbook of Fluid Mechanics and Hydraulic Machines*", 9th ed. Laxmi Publications, New Delhi, 2004
4. Hougen, O.A., Watson, K.M., and Ragatz, R.A. - Chemical Process Principles- Part-I, CBS Publishers and Distributors, New Delhi – 1995 (2^{nd} Edition)
5. Geankoplis, C.J. - Transport Processes and Unit Operations - Prentice Hall of India, New Delhi – 2002 (3^{rd} Edition)

212BIT1303	CELL AND MOLECULAR BIOLOGY	L	T	P	X	C
		3	0	2	0	4

Course objective(s):

To gain basic knowledge about cell, its type, functions, cell cycle and regulation, cellular transport and knowledge on DNA, genes, genome and various concepts in molecular biology

Course Outcomes:

At the end of the course, students would be able to

CO1: Distinguish prokaryotic cell from eukaryotic cell and describe the structure and function of different parts of a eukaryotic cell

CO2: Explain the mitosis and meiosis cell division and the consequences

CO3: Demonstrate the cell membrane transport mechanism

CO4: Summarize DNA and RNA as genetic material, packing of genes in chromosomes, replication in prokaryotes and eukaryotes, repair and mutagenesis

CO5: Understand RNA polymerase, transcription and translation in both prokaryotes and eukaryotes, post-transcriptional and post-translational modifications

Mapping of Course Outcomes

CO /PO/PSO	PO												PSO		
	1	2	3	4	5	6	7	8	9	10	11	12	1	2	3
CO1	H			H						M		M	M		
CO2	H			H						M		M	M		
CO3	H		M	H	H	M				M		H	M		
CO4	H		M	H						M			M		
CO5	H		M	H	H	M				M		H	M		

UNIT I CELL STRUCTURE AND FUNCTION OF ORGANELLES 9 hours

Development of cell theory; general organization of prokaryotic and eukaryotic cells: structure, chemical composition and function; organization of cell membrane: plasma membrane (fluid mosaic model), chemical composition and function; intracellular compartmentalization; cytosol, mitochondria and oxidative phosphorylation, chloroplast and photosynthesis; endomembrane system: structure and function of endoplasmic reticulum and golgi complex; lysosomes and cellular digestion; role of vacuole and peroxisomes; extra cellular matrix.

UNIT II CELL CYCLE AND CELLULAR REPRODUCTION 9 hours

Cell cycle: different stages, M phase and interphase; mitosis: prophase, metaphase, anaphase and telophase, cytokinesis; meiosis: different stages, significance of meiosis, post-reductional meiosis & chiasma terminalization; comparison of mitosis and meiosis; cell cycle check points: role of cyclins and CDK in cell cycle; cell cycle regulation; autophagy, apoptosis and necrosis.

UNIT III CELLULAR TRANSPORT AND SIGNAL TRANSDUCTION 9 hours

Passive, facilitated and active transport; transport pumps: $Na^+/K^+/Ca^{2+}$ pumps, ATP pumps; uniport, symport, antiport; non-gated and gated ion channels; endocytosis, exocytosis, phagocytosis; cell-cell communication; cell signalling: autocrine, paracrine, endocrine, direct signalling; internal, cell surface receptors; types: enzyme-linked, tyrosine kinase, ion channel-linked, G-protein-linked receptors; signal transduction: protein phosphorylation by protein kinases, secondary messengers: cAMP, Ca^{2+} and Inositol Triphosphate (IP_3); protein trafficking.

UNIT IV CONCEPTS IN MOLECULAR BIOLOGY 9 hours

Structure of DNA and RNA; genes, genomes and DNA packaging**;** organization of prokaryotic and eukaryotic genomes; supercoiling; prokaryotic and eukaryotic DNA replication: mechanisms, enzymes, accessory proteins, inhibitors; DNA repair and mutagenesis-types of mutations; non-coding and micro RNA; RNA interference.

UNIT V TRANSCRIPTION, TRANSLATION AND MODIFICATIONS 9 hours

RNA polymerases, types of RNA; eukaryotic and prokaryotic transcription: mechanisms, enhancers, inhibitors; transcription factors; splicing, post transcriptional modifications; genetic code; prokaryotic and eukaryotic translation: mechanisms, regulation, inhibitors; post translational modifications.

Text Book(s)

1. De Robertis, E.D.P and De Robertis, E.M.F.–Cell and Molecular Biology–Lippincott Williams & Wilkins, Philadelphia, USA–2010 (8th Edition).
2. Allison, L.A–Fundamental Molecular Biology–Blackwell publishing group, Malden, MA, USA–2007 (1st edition)
3. Friefelder. D–Molecular Biology–McGraw-Hill Companies, New York, USA–2013 (5th edition)

Reference(s)

1. Hardin, J., Bertoni, G.P. Kleinsmith, L.J.–Becker's World of the Cell–Pearson Publ–2011 (8th Edition)
2. Alberts, B., Bray, D., Hopkin, K., Johnson, A., Lewis, J., Raff, M., Roberts, K., Walter, P–Essential Cell Biology–Garland Science, New York–2013 (4th Edition)
3. Clark, D.P. and Pazdernik, N.J–Molecular Biology–Elsevier Academic Press–2013 (2nd edition)

List of Experiments: 45 hours

1. Cell fractionation - isolation of sub cellular organelles such as mitochondria, chloroplast etc.
2. Cell division in Onion root tip
3. Isolation of Squamous Epithelial cells
4. Isolation of protoplast from plant leaves
5. Isolation of Polytene Chromosomes of Dipterans
6. Estimation of nucleic acids
7. Isolation of plasmid DNA from bacteria
8. Agarose gel electrophoresis
9. Preparation of competent cells and transformation
10. Isolation of genomic DNA from bacteria
11. Isolation of genomic DNA from plant
12. Isolation of genomic DNA from animal cell
13. Restriction enzyme digestion
14. Separation of Proteins – SDS PAGE

212BIT1304	BIOINFORMATICS	L	T	P	X	C
		3	0	2	3	5

Course Objective:

Students can demonstrate the usage of *in silico* tools, software and databases for understanding the bio molecular data

Course Outcomes:

At the end of the course, students would be able to

CO1: Understand the brief history of bioinformatics

CO2: Explain the basics of computers and bioinformatics

CO3: Elaborate the programming languages used in bioinformatics

CO4: Perform the analysis of bio-molecular sequences and structures using tools and software

CO5: Enumerate the advanced branches of bioinformatics

Mapping of Course Outcomes:

CO/	PO												PSO		
PO/PSO	1	2	3	4	5	6	7	8	9	10	11	12	1	2	3
CO1										H		M	H		
CO2	H			M	H				H	H			H		
CO3	M			H	M				H	H			H		
CO4	H	H		M	M				H	H			H		
CO5	M			H	H				H	H			H		

Unit 1: History of Bioinformatics **9 hours**

First sequence of a protein-Insulin; Margaret Dayhoff - Atlas of Protein Sequence and Structure - Comprotein; Emile Zuckerkandl and Linus Pauling – Paleogenetics; Walter M Fitch – Orthology; Needleman and Wunsch – Dynamic Programming Algorithm; Da-Fei Feng and Russell F. Doolittle; Dayhoff, Schwartz and Orcutt –Amino Acid Substitution; Genetic code; Maxam-Gilbert Sequencing; Ernest Haeckel –Phylogenetics; GCG suite; Richard Stallman –GNU; INSDC; Larry Wall- Perl; Guido van Rossum-Python; J. Craig Venter-Genome Sequencing

Unit 2: Basics of Computers and Bioinformatics **9 hours**

Computer-Types-Hardware-Software-Network; Bioinformatics-Sequence, Structure and Expression Analysis- Bioinformatics Databases- Primary, Secondary, Composite, Sequence, Structure, Literature, Pathway, Disease and Compound Databases

Unit3: Programming Languages for Bioinformatics **9 hours**

Programming languages for bioinformatics-C-C++-JAVA-Python

Unit4: Bio-molecular Sequence and Structure Analysis Tools and Software **9 hours**

Local and Global Alignment of Sequences-BLAST, LALIGN, FASTA, Water, Matcher, Stretcher, Needle; Multiple Alignment of Sequences- Clustal Omega, EMBOSS Cons, Kalign, MAFFT, MUSCLE, T-Coffee; Phylogenetic Analysis; Structure Analysis of Proteins-Primary-Secondary-Tertiary-Quaternary

Unit5: Advanced branches of Bioinformatics **9 hours**

Computational Biology; Genome, Transcript and Protein Informatics; Systems Biology; Transcriptomics; Metabolomics.

LIST OF EXPERIMENTS: **45 hours**

Experiment 1 - Accessing Biological Databases
Experiment 2 - Analysing Genomes
Experiment 3 - Accessing Uniprot
Experiment 4 - Pairwise Sequence Alignment
Experiment 5 - Database Similarity Search Using Blast
Experiment 6 - Multiple Sequence Alignment
Experiment 7 - Phylogenetic Analysis

Experiment 8 - Retrieval and Visualization of Protein Structures
Experiment 9 - Protein Structure Visualization Using Rasmol
Experiment 10 - Analysis of Primary Structure of a Protein Using Protparam
Experiment 11 - Prediction of Secondary Structure of Proteins
Experiment 12- Homology Modeling
Experiment 13- Accessing Ligand Databases
Experiment 14 - Sketching Small Molecule Structures

X-COMPONENT: **15 hours**

X-Component Activity – Mini Project
NCBI will be used for retrieval of protein sequences as per the objective of the mini project
UNIPROT will be used for studying the characteristics of protein sequences
PREDICT PROTEIN will be used for predicting the primary structure of proteins
GOR, JPRED, PSIPRED will be used for predicting the secondary structure of proteins
Matcher and Stretcher will be used for pairwise alignment of protein sequences
EMBOSS Cons, Kalign, MAFFT, MUSCLE, T-Coffee will be used for multiple sequence alignment of protein sequences
STRING will be used for studying the functional interaction between the proteins
ngLOC, WoLF PSORT, PSORT, TMHMM, PHOBIUS and SIGNAIP will be used for sub-cellular localization and signal peptide prediction of protein sequences

Text Book:

1. Xiong, J. (2014). Essential Bioinformatics. United States: Cambridge University Press.
2. Gromiha, M. M. (2011). Protein Bioinformatics: From Sequence to Function. India: Elsevier Science.
3. Bassi, S. (2018). Python for Bioinformatics. United States: CRC Press LLC.
4. Model, M. (2010). Bioinformatics Programming Using Python. United States: O'Reilly Media.
5. Gentleman, R. (2008). R Programming for Bioinformatics. United Kingdom: CRC Press.
6. Jamison, D. C. (2003). Perl Programming for Biologists. Ukraine: Wiley.

References:

1. Ghosh, Z., Mallick, B. (2008) Bioinformatics: Principles and Applications. India: Oxford University Press.
2. Mount, D. W., Cao, Z. (2006) Bioinformatics: Sequence and Genome Analysis. China.
3. Zvelebil, M., Baum, J. O., Zvelebil, M. J., Zvelebil, M. J. (. I. o. C. R. (2008). Understa nding Bioinformatics. United Kingdom: Garland Science.

212BIT2305	BIOPROCESS PRINCIPLES	L	T	P	X	C
		3	1	2	0	5

Course objective(s):

To provide overview of fermentation process, basic design of fermenter, media optimization, sterilization kinetics and to solve basic problems related to metabolic stoichiometry and kinetics of growth and product formation

Course Outcomes:

At the end of the course, students would be able to

CO1: Explain fermenter design and list the roles of a bioprocess engineer in the bioprocess industry

CO2: Summarize the role of medium formulation and optimization in fermentation processes

CO3: Describe sterilization kinetics and the modes of sterilization

CO4: Apply metabolic stoichiometry and energetics data in assessing and optimizing fermentation process

CO5: Express microbial growth kinetics in various modes of fermentation

Mapping of Course Outcomes:

CO / PO/ PSO	PO												PSO		
	1	2	3	4	5	6	7	8	9	10	11	12	1	2	3
CO1	M	H			M				M				H	H	
CO2	M	H		H	M				M				H	H	M
CO3	M	H		M					M				H	H	M
CO4	M	H		M	M				M				H	H	
CO5	M	H		M	M				M				H	H	

Unit 1: OVERVIEW OF FERMENTATION PROCESS 12 hours

Overview of fermentation industry - General requirements of fermentation processes, basic configuration of fermenter and ancillaries, Instrumentation in bioprocess: main parameters to be monitored and controlled in fermentation processes - Role of bioprocess engineer in the biotechnology industry - Unit operations involved in bioprocesses - Modern applications of biotechnological processes

Unit 2: MEDIA AND MEDIUM OPTIMIZATION FOR BIOPROCESS 12 hours

Criteria for good medium - Medium requirements for fermentation processes and the factors influencing the choice of medium - carbon, nitrogen, minerals, vitamins and other complex nutrients, oxygen requirements and antifoams –Medium formulation of optimal growth and product formation, examples of simple and complex media - Design of various commercial media for industrial fermentations (Case studies) - Medium optimization methods - Plackett-Burman and Response Surface Methodology- Overview of animal and plant cell culture media

Unit 3: STERILIZATION KINETICS AND EFFLUENT TREATMENT 12 hours

Sterilization - Thermal death kinetics of microorganisms –Batch and continuous heat sterilization of liquid media - Filter sterilization of liquid media – Design of filters; Air sterilization and design of sterilization equipment-Sterilization of fermenter- Effluent treatment in bioprocesses, types of treatment methods, containment and effluent disposal.

Unit 4: METABOLIC STOICHIOMETRY AND ENERGETICS 12 hours

Stoichiometry of cell growth and product formation - Elemental balances, degrees of reduction of substrate and biomass, available electron balances - Yield coefficients of biomass and product formation, maintenance coefficients, energetic analysis of microbial growth and product formation - Oxygen consumption and heat evolution in aerobic cultures, Thermodynamic efficiency of growth

Unit 5: KINETICS OF MICROBIAL GROWTH AND PRODUCT FORMATION 12 hours

Biomass estimation – Direct and Indirect methods- Types of feeding- Modes of operation - Batch, fed batch, continuous, perfusion cultivation; Industrial applications - Chemostat - Turbidostat - Introduction to unstructured models for growth and product formation - Simple unstructured kinetic models for microbial growth - Monod model - Growth of filamentous organisms - Product formation kinetics - Leudeking Piret model, Substrate and product inhibition on cell growth and product formation

List of Experiments: 60 hours

1. Determination of bacterial growth by turbidity measurement; measurement of biomass by dry weight
2. Study of factors affecting microbial growth
3. Growth kinetics of bacteria – estimation of biomass, calculation of doubling time, specific growth rate, yield coefficient in shake flask culture
4. Growth of yeast - estimation of biomass, calculation of doubling time, specific growth rate, yield coefficient in shake flask culture
5. Screening of industrially important microorganisms for enzyme production
6. Enzyme production in shake flasks
7. Estimation of enzyme activity (amylase); Calculation of specific activity
8. Enzyme kinetics – Evaluation of Michaelis- Menten parameters
9. Effect of pH and temperature on enzyme activity
10. Immobilization of yeast cells and enzyme immobilization - gel entrapment
11. Kinetics of immobilized enzyme reactions

Text Book (s)

1. Shuler, M.L. and Kargi, F.- Bioprocess Engineering-Basic Concepts- Prentice Hall Pvt. Ltd., New Delhi- 2018 (3rd Edition)
2. Stanbury P, Whitaker A, Hall. S - Principles of Fermentation Technology- Elsevier (An Imprint of Butterworth-Heinemann)- 2016 (3rd Edition)

Reference (s)

1. Doran, P.M. - Bioprocess Engineering Principles - Academic Press (An Imprint of Elsevier) New Delhi- 2013 (2nd Edition)
2. Bailey, J.E. and Ollis, D.F. - Biochemical Engineering Fundamentals - McGraw Hill Publishers, New Delhi- 2004 (2nd Edition)
3. James Lee, M. - Biochemical Engineering - Prentice-Hall Inc Publishers, Delhi- 1992 (1st Edition)
4. Blanch H. W. and Clark, D. S. - Biochemical Engineering - Macel Dekker Inc., - 1997 (2nd Edition)

212BIT2306	GENETIC ENGINEERING	L	T	P	X	C
		3	1	2	0	5

Course Objective(s):
To describe enzymes and types of vectors involved in cloning how to create recombinant proteins and its various purification steps; to describe the construction, and application of genetically modified plants and animals

Course Outcomes:
After completing this course, the student will be able to:

CO1: Summarize the enzymes involved in cloning and restriction enzymes in recombinant DNA technology
CO2: Describe the methods and factors involved in creating recombinant DNA molecules.
CO3: Explain the cloning of a gene in vectors, expression and purification of proteins and its applications
CO4: Illustrate construction and screening of cDNA and genomic libraries.
CO5: Describe the application of recombinant DNA technology in animal, plant and industry

Mapping of Course Outcomes:

CO / PO/ PSO	PO												PSO		
	1	2	3	4	5	6	7	8	9	10	11	12	1	2	3
CO1	H					M							M		
CO2	H					M	M							M	
CO3	H	M				M					M	H	M		
CO4	H					M	M		M						M
CO5	H	H	M		H	M		H			M			H	

Unit 1:BASICS OF RECOMBINANT DNA TECHNOLOGY 12 Hours
Gene expression –overview, genetic elements that control gene expression, transcription factors, regulation of gene expression, chromosomal mapping,- Restriction and modifying enzymes - Restriction mapping, DNA methylation - Safety guidelines of recombinant DNA research

Unit 2: CREATION OF RECOMBINANT MOLECULES 12 Hours
Characteristics of plasmid and phage vectors - Prokaryotic and eukaryotic expression vectors - Insect, yeast and mammalian vectors - promoters used in expression vectors, Method of creating recombinant DNA molecules - Cloning strategies- restriction digestion - blunt and cohesive end ligation – design of linkers and adaptors - cloning after homopolymer tailing; cloning of genes in correct reading frame in expression vector, Promoter problem, Cosak sequences

Unit 3:EXPRESSION OF RECOMBINANT PROTEIN 12 Hours
Strategies for cloning PCR products – different types of PCR- Primer designing- Creation of restriction sites, Types of polymerases used in PCR, role of Dpnl in site-directed mutagenesis, Factors involved in expression of cloned genes, IPTG induction, inclusion bodies, Strategies

for purification of recombinant proteins (Size exclusive, Affinity, IMAC chromatography), Synthetic Biology: Chemical synthesis of DNA - *E. coli* and Mycoplasma

Unit 4:CONSTRUCTION OF LIBRARIES 12 Hours

Characterization of recombinant clones by Southern & Western Blotting - Characterization of recombinant clones by Northern Blotting & PCR analysis - Construction of cDNA libraries - Construction of genomic libraries - Screening of libraries with DNA probes and antisera

Unit 5:APPLICATIONS OF RECOMBINANT DNA TECHNOLOGY 12 Hours

Methods of gene transfer - Gene transfer in animals - Applications of recombinant technology in pharmaceutical industry & medicine: Transgenic and knockout animals, Genome editing techniques, Gene expression profiling: transcriptome analysis. Case study for recombinant insulin production in diabetic patients

List of Experiments:

1. Isolation of chromosomal DNA from bacteria
2. Sub-cloning of a gene in *E. coli* – (restriction digestion, gel isolation and ligation, transformation and screening of recombinants)
3. Polymerase Chain Reaction
4. Restriction digestion
5. Isolation of RNA, first and second strand synthesis of cDNA
6. Southern blotting
7. Northern blotting
8. Western blotting
9. Colony hybridization
10. Site-directed mutagenesis

Text Book:

1. Primrose, S., B. and Twyman, R., M., Principles of Gene Manipulation and Genomics, Blackwell Publishing Co., 7thEdition, 2006.
2. Brown, T.A.,Gene Cloning and DNA analysis-An Introduction, Blackwell Science, 2nd Edition, 2001.

Reference(s):

1. Lodge, J., Lund, P., and Minchin, S., Gene Cloning, Taylor & Francis Group
ISBN: 0-7487-6534-4, 2007.

212BIT3307	BIOCHEMICAL ENGINEERING	L	T	P	X	C
		3	1	2	3	6

Course objective(s):
To study the design, analysis, scale-up of bioreactors and to provide knowledge on modeling and simulation of bioprocess

Course Outcomes:
At the end of the course, students would be able to
CO1: Explain ideal and non-ideal behavior of reactors and describe the configurations and applications of various bioreactors.
CO2: Suggest scale up of design parameters for bioreactors.
CO3: Develop and apply the models of bioprocess
CO4: Illustrate recombinant cell culture process and design considerations for animal and plant cell culture
CO5: Understand the design of immobilized cell and enzyme reactors

Mapping of Course Outcomes:

CO / PO/ PSO	PO												PSO		
	1	2	3	4	5	6	7	8	9	10	11	12	1	2	3
CO1	H	H		M									H	H	M
CO2	H	H											H	H	M
CO3	H	H		M									H	H	
CO4	H	H		M	M								H	H	
CO5	H	H		M									H	H	

Unit 1: DESIGN AND ANALYSIS OF BIOREACTORS 12 hours
Ideal reactors-Non-ideal behavior, RTD- Tanks-in-series and dispersion models - Application to design of continuous sterilizers - Design and operation of novel bioreactors -airlift reactor, bubble column reactor-Stability analysis of bioreactors

Unit 2: SCALE UP OF BIOREACTORS 12 hours
Role of mass transfer in bioprocessing-Oxygen mass transfer in bioreactors - Microbial oxygen demands (OUR, OTR) - Methods for the determination of mass transfer coefficients- Factors affecting k_La - Mass transfer correlations - Scale up criteria for bioreactors based on oxygen transfer - Power consumption and impeller tip speed- Bioreactor scale up case studies-Regime analysis of bioreactors

Unit 3: MODELLING AND SIMULATION OF BIOPROCESSES 12 hours
Study of structured models for analysis of various bioprocesses - Compartmental models, cybernetic models - Models of cellular energetic and metabolism - Single cell models, plasmid replication and plasmid stability model - Age distribution model for the production of antibiotics- MATLAB-SIMULINK- Dynamic simulation of batch, fed batch, steady and transient culture metabolism

Unit 4: MODERN BIOTECHNOLOGICAL PROCESSES 12 hours
Recombinant cell culture processes- Guidelines for choosing host-vector systems, plasmid stability in recombinant cell culture - Limits to over expression - Bioreactor strategies for maximizing product formation (recycle bioreactors, multi-stage bioreactors) - Bioprocess design considerations for plant and animal cell cultures

Unit 5: BIOREACTOR CONSIDERATIONS IN IMMOBILIZED CELL AND ENZYME SYSTEMS **12 hours**

Kinetics of immobilized enzymes- Diffusional limitations in immobilized systems-Analysis of film and pore diffusion effects- Design of immobilized cell/enzyme reactors – Packed bed, fluidized bed and membrane reactors-Case studies

LIST OF EXPERIMENTS: **60 hours**

1. Demonstration of various bioreactor configurations, parts and integrated process control systems.
2. Batch sterilization design and Thermal death kinetics
3. Medium optimization – Plackett Burman design
4. Estimation of k_La by sulphite oxidation method.
5. Determination of volumetric mass transfer coefficient k_La by static gassing out method
6. Estimation of mixing time in batch reactor.
7. Residence time distribution analysis CSTR, PFR
8. Bioconversion studies with immobilized enzyme using packed - bed reactors
9. Demonstration of fluidized bed reactor
10. Batch cultivation, estimation of k_La – Dynamic gassing method, exhaust gas analysis – carbon balancing, gas balancing.
11. Study of product formation kinetics
12. Model simulation using MATLAB-SIMULINK
13. Dynamic simulation of batch, continuous and fed-batch cultivation

Text Book

1. Blanch, H. W. and Clark, D. S. - Biochemical Engineering- Macel Dekker Inc., - 1997 (2^{nd} Edition)

References

1. Shuler, M.L. and Kargi, F. - Bioprocess Engineering-Basic Concepts - Prentice Hall Pvt. Ltd., New Delhi – 2006 (2^{nd} Edition)
2. Doran, P.M. - Bioprocess Engineering Principles- Academic Press (An Imprint of Elsevier), New Delhi – 2013 (2^{nd} Edition)
3. Bailey, J.E. and Ollis, D.F. - Biochemical Engineering Fundamentals- McGraw Hill Publishers, New Delhi - 2004 (2^{nd} Edition)
4. James Lee, M. - Biochemical Engineering- Prentice-Hall Inc Publishers, New Delhi-1992 (1^{st} Edition)

212BIT3308	IMMUNOLOGY	L	T	P	X	C
		3	1	2	0	5

Course Objective(s):

To learn the basic immunological processes that enable the host to fight infections and other threats that the host may face and, to understand various immunological disorders and immune based treatment modalities.

Course Outcomes:

After completing this course, the student will be able to:

CO1: Understand the immune system and their role in host defense, role lymphoid organs, immune cells and molecules like complement.

CO2: Explain the structure and function of immunoglobulins, and genetic regulation of antibody and development, maturation and activations of B-Lymphocytes.
CO3: Describe the role of T-cells in immunity, different types of antigen presenting cells and how the antigens are processed and presented.
CO4: Explain the role of immune system against microbial infections and tumour
CO5: Describe the mechanisms involved in Graft rejection, mode of action of immunosuppressive drugs, the basis for allergy and autoimmune diseases and their treatment.

Mapping of Course Outcomes:

CO / PO/ PSO	**PO**												**PSO**		
	1	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**	**12**	**1**	**2**	**3**
CO1	M	H	M		M	M		H			M	M	M		
CO2	H	M		M	M	M		M		M	M			H	
CO3	M	M			H	M				M					
CO4	M	M		M	H	M		M			M	M			M
CO5	H	M		M	H	M		H				M			

Unit 1: The Immune System **12 hours**

Historical perspectives in immunology - introduction to the immune system - innate and acquired immune responses; lymphoid organs: Primary and secondary, anatomy of lymphoid organs; Cells of the immune system: NK cells, Lymphocytes, their origin and differentiation – humoral and cell mediated immune response - Antigens, their structure and classification - Complement system and their biological functions.

Unit 2: Humoral Immunity **12 hours**

B-Lymphocytes and their activation and differentiation - Structure and function of immunoglobulins: immunoglobulin classes and subclasses; immunoglobin gene rearrangement and generation of antibody diversity - mechanism of activation – co-stimulatory molecules – class switching and memory - polyclonal antibodies; hybridoma: monoclonal antibodies, chimeric and humanized monoclonal antibodies -idiotope and antibodies- antigen-antibody interactions: principles and applications.

Unit 3: Cellular Immunology **12 hours**

T lymphocytes: subsets of T cells - T cell receptors – T cell production and maturation - Antigen presenting cells - Antigen processing and presentation- role of MHC - activation and differentiation of CTLs and T-helper cells Cytokines and their functional role in immune response

Unit 4: Immunity to Infection **12 hours**

Microbial pathogenicity – virulence factors - humoral response to pathogens, cellular response to pathogens - Host-pathogen interaction - immunity to mucosal surfaces; Cancer and the immune system: mechanisms of immunity to tumor antigens; Case studies in infection and immunity

Unit 5: Transplantation and Autoimmunity **12 hours**

Transplantation: tissue and organ grafting - graft versus host reaction**,** graft rejection - mechanisms of graft rejection - prevention of graft rejection – immunosuppression - immunosuppressive drugs - HLA and disease. Immunologic tolerance and autoimmunity – autoimmune diseases: examples, pathogenesis, experimental models and Treatment of autoimmune disorders; AIDS and other immune deficiencies - Hypersensitivity reactions – IgE and allergy - case studies

Text Book:

1. Abbas, A.K., A.H. Lichtman, S. Pillai. Basic Immunology: Functions and Disorders of the Immune System, 6th edition, Elsevier, 2019
2. Janes Kuby., Immunology, WH Freeman and Company, New York, 7th Edition 2013

Reference(s):

1. Robert R. Rich, Thomas A Fleisher, William T. Shearer, Harry Schroeder, Anthony J. Frew, and Cornelia M. Weyand, (2013). Clinical Immunology, 4th Edition, Elsevier Limited.
2. Jeneway, C. A Jr. and Travers, P.T., Immunobiology, Blackwell Scientific Publishers, Oxford, 8th Edition 2014
3. Roitt, I., Essential Immunology, Blackwell Scientific Publications, Oxford, 12th Edition 2011

List of Experiments: **45 hours**

1. Agglutination: identification of blood group
2. Single Radial Immunodiffusion
3. Outcherlony double diffusion
4. Immunoelectrophoresis
5. Rocket Immunoelectrophoresis
6. Animal handling: immunization and bleeding of mouse, rat and rabbit
7. Isolation of lymphocytes from spleen
8. Complement Fixation test
9. ELISA: Dot and plate ELISA
10. Sandwich ELISA
11. Western blot

212BIT3309	BIOSEPARATION PRINCIPLES AND APPLICATIONS	L	T	P	X	C
		3	1	2	3	6

Course objective(s):

To provide understanding of the principles and applications of downstream processing

Course Outcomes:

At the end of this course, students will be able to

CO1: Recognize the fundamental understanding of physical and chemical properties of biological materials and their separation and purification

CO2: Explain the various principles that underlie major unit operations used in bioseparations such as settling, evaporation, centrifugation, and membrane filtration.

CO3: Explain the principles of protein precipitation, aqueous two phase extraction, adsorption and chromatography

CO4: Describe the various concepts of final bioproduct formulation and finishing operations such as crystallization, drying and lyophilization

CO5: Sketch different types of process to recover and purify the bio-molecules.

Mapping of Course Outcome(s):

CO / PO/ PSO	**PO**												**PSO**		
	1	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**	**12**	**1**	**2**	**3**
CO1	H												H		
CO2	H		M		M								H	H	
CO3	H		M		M								H	H	
CO4	H												H	H	M
CO5	H	H	H				H		M				H	H	M

Unit 1: Introduction and Importance of Bioseparations 12 Hours

Characteristics of biomolecules and their differences, range and characteristics of bioproducts, characteristics of fermentation broths, fundamental principles of obtaining the product from cell cultures – intracellular vs. extracellular product, Cell disruption methods, overview and importance of various bioseparation methods

Unit 2: Physical Methods of Separation 12 Hours

Settling and Sedimentation, Unit operation for solid-liquid separation - filtration and centrifugation, types of evaporators, multiple effect evaporators, industrially important membrane separation processes: reverse-osmosis, ultrafiltration and micro-filtration.

Unit 3: Isolation of Products 12 Hours

Precipitation and its mechanism, concentrating and purifying antibiotics and proteins, Single-stage equilibrium extraction; types of equipment and design for extraction, aqueous two phase extraction, Adsorption processes, isotherms and techniques, Chromatography, basic principles, classification instruments and practice: ion exchange, affinity, hydrophobic interaction, reversed phase, fast protein liquid and gel filtration.

Unit 4: Product Formulation and Finishing Operations 12 Hours

Stabilization of bioproducts, Crystallization, theory and types of crystals, equipment for crystallizations, Introduction and methods of drying, Freeze-drying of biological materials. Large scale purification of recombinant proteins and metabolites

Unit 5: Applications and Case Studies **12 Hours**

Separation of targeted recombinant proteins, case studies: recovery of enzymes and byproducts from genetically modified microbes, downstream processing of bioproducts from transgenic feedstock.

List of Experiments **60 Hours**

1. Disruption of bacterial cells by ultrasonication
2. Precipitation of protein by ammonium sulphate
3. Extraction of proteins from *E. coli* by enzymatic cell disruption
4. Adsorption of acetic acid from aqueous solution by activated carbon
5. Solid-Liquid separation by centrifugation
6. Aqueous two-phase extraction
7. Isoelectric precipitation of casein from milk
8. Solid-liquid separation by microfiltration
9. Resolving of mixtures of amino acids by Thin Layer chromatography
10. Crystallization of salicylic acid.

Textbook(s):

1. Harrison R G, Todd P, Todd P W, Petrides DP, Rudge SR - Bioseparations Science and Engineering - Oxford University Press, USA - 2015
2. Ladisch, M. R - Bioseparations Engineering: Principles, Practice and Economics – Wiley, New York - 2001
3. Belter Paul A., Edward L Cussler, and W. Hu - Bioseparations: downstream processing for biotechnology - Wiley, New York - 1987.

Reference(s):

1. Sivasankar B - Bioseparations: Principles and Techniques - PHI Learning Pvt. Ltd. - 2005.
2. Gajanan Gaikar V, Doble M, Kurnar Kruthiventi A - Biotransformations and bioprocesses - CRC Press - 2004.
3. Scopes R K - Protein purification: principles and practice - Springer Science & Business Media - 2013.
4. Desai M A - Downstream processing of proteins: methods and protocols - Springer Science & Business Media - 2000.

212MAT2302	**NUMERICAL METHODS AND LAPLACE TRANSFORMS**	**3**	**0**	**0**	**0**	**3**

Course Outcomes:

CO 1: To solve system of equations and understand concepts of eigen values, errors
CO 2: To understand and appreciate numerical differentiation and integration
CO 3: To solve Initial Value Problems for ODEs
CO4: To analyze Boundary Value Problems for PDEs
CO5: To apply Laplace Transforms

Mapping of course outcomes

CO/ PO/ PSO	PO												PSO		
	1	2	3	4	5	6	7	8	9	10	11	12	1	2	3
CO1	H	H		M									H	H	
CO2	H	H		M											
CO3	H	H		M									H	H	
CO4	H	H		M										H	
CO5	H	H		M											

Unit I Solution of Equations and Eigen Values **9 hours**

Solutions of algebraic and transcendental equations: Iteration method and Newton-Raphson method – Solutions of linear simultaneous equations: Direct methods – Gauss elimination method and Gauss Jordan method – Iterative methods - Gauss Jacobi method and Gauss-Seidel method – Matrix inversion by Gauss Jordan method – Eigen values of a matrix by Jacobi method-Errors in numerical computation, Error type, Analysis and Estimation

Unit II Numerical Differentiation and Integration **9 hours**

Approximation of derivatives using Newton's forward and backward difference interpolation, Newton's divided difference interpolation and Lagrange's interpolation – Gauss forward and backward difference interpolation-Numerical integration using Trapezoidal rule and Simpson's rules.

Unit III Initial Value Problems for Ordinary Differential Equations **9 hours**

Single step methods- Taylor series method, Euler and Modified Euler methods- Runge Kutta Method for first order, simultaneous and second order equations - Multi-step method - Milne's predictor-corrector methods for solving first order equation.

Unit IV Boundary Value Problems for Partial Differential Equations **9 hours**

Finite difference techniques for the solution of two dimensional Laplace and Poisson equations for rectangular domain – One dimensional heat-flow equation by explicit and implicit methods

UNIT V Laplace Transforms **9 hours**

Existence conditions – Transforms of elementary functions – Transform of unit step function and unit impulse function – Basic properties – Shifting theorems – Transforms of derivatives and integrals – Initial and Final Value Theorems – Inverse Transforms – Convolution Theorem – Transform of periodic functions – Application to solution of linear ordinary differential equations with constant coefficients.

PROGRAMME ELECTIVE COURSES

213BIT1101	GENETICS	L	T	P	C
		3	0	0	3

Course Objectives:

To gain basic knowledge about the fundamentals of genetics, sex determination and genetic disorders

Course outcome(s):

At the end of the course, students would be able to

CO1: To summarize the concepts of Mendelian genetics

CO2: To describe about the sex determination and gene frequency

CO3: To analyze the organization of chromosome and mutations

CO4: To illustrate the principles of DNA linkage and mapping

CO5: To Outline the various genetic disorders

Mapping of course outcomes

CO / PO/ PSO	PO												PSO		
	1	2	3	4	5	6	7	8	9	10	11	12	1	2	3
CO1	H	M		H						M		M	M		
CO2	H	M		H						M		M	M		
CO3	H		M	H	M	M				M		H	M		
CO4	H		M	H	M					M			M		
CO5	H		H	H		M				M		H	M		

Unit 1: Mendelian Genetics **9 hours**

Mendelian Experiments with pea plants, monohybrid and dihybrid crosses, back cross, test cross, genetic ratios, self-pollination and cross pollination–Mendelian laws of inheritance, law of segregation and laws of independent assortment–Dominance and lethal genes–Dominance relationships, lethal gene action, gene interactions and Epistasis.

Unit 2: Sex Determination and Gene Frequency **9 hours**

Vehicles of heredity, Hardy Weinberg Equilibrium, Deviations from Hardy Weinberg Equilibrium, Genefrequency Allele and Genotype Frequencies, sex determination in plants and animals,sex linked inheritance– Inheritance patterns and Pedigrees, Pedigree symbols and analysis,Extra chromosomal inheritance

Unit 3: Applied Genetics **9 hours**

Chromosome organization, structure and variation in prokaryotes and eukaryotes, Mutations and mutagenesis, Giant chromosomes – polytene and lampbrush, deletion, inversion, translocation, duplication. Variation in chromosomal numbers – aneuploidy, euploidy, polyploidy, Ames test, karyotyping

Unit 4: Linkage and Mapping: **9 hours**

Linkage and chromosome mapping: Linkage and recombination, linkage maps, linkage mapping with molecular markers, DNA testing, DNA tests for identity and relationships including forensic capplications, Crossing over – cytological basis of crossing over, interference, coincidence, genotype frequency, somatic cell hybridization.

Unit 5: Genetic diseases **9 hours**

Inborn errors of metabolism, Molecular basis of diseases, Autosomal dominant disorders, Hemoglobinopathies, colour blindness, hemophilia, Sickle cell, hemochromatosis, hypogonadotropic hypogonadism, Huntington's Disease, Cystic fibrosis, Age-related macular degeneration, Obesity, Type 2 diabetes, Psychiatric disease, including missing heritability, autism

Text Book(s)

1. Gardner, E.J., Simons, M.J., Snustad, D.P–Principles of Genetics–Wiley-India Ltd,New Delhi–2008 (8^{th} Edition)
2. Griffiths AJF, Wessler SR, Lewontin RC and Carroll SB (2015). An Introduction to genetic analysis. 11thed. W.H Freeman.

Reference(s)

1. Strachan, T., and Read A.P.–Human Molecular Genetics–Garland Publishing–2004(3^{rd} Edition).
2. David L. Rimoin, Reed E. Pyeritz, Bruce Korf (2013). Emery and Rimoin's Essential Medical Genetics. Elsevier.
3. Hartl, D.L. et al. (2012). Genetics: Analysis of Genes and Genomes, 8th ed., Jones and Bartlett Publishers.

213BIT1102	HUMAN ANATOMY AND PHYSIOLOGY	L	T	P	C
		3	0	0	3

Course Objective(s):

To describe general features and various types of anatomical and physiological systems in human and, how they are performing functions through organs and its applications

Course Outcomes:

At the end of the course, students would be able to

CO1: List the general and basics of human body orientations and skin architecture

CO2: Demonstrate structure, types and function of skeletal, muscular and digestive system

CO3: Explain and illustrate how respiratory, circulatory and nervous system are performing functions in human systems

CO4: Discuss reproductive, urinary and endocrine system are how efficiently regulating the functions in human systems

CO5: Explain important applications which are involved in the functional validation of physiological and anatomical test

Mapping of Course Outcomes:

CO / PO/ PSO	PO												PSO		
	1	2	3	4	5	6	7	8	9	10	11	12	1	2	3
CO1	H			H		H				H	M		H	M	
CO2	H			M	M			M	H			M	H	M	
CO3	H	H					M		M		M		H	M	
CO4	H	H	M		H	M				M			H	M	
CO5	H			M			M	M			M	M	H	M	

Unit 1: HUMAN BODY AND ITS ORIENTATION

An overview of anatomy and physiology, levels of structural organization, from atoms to organism, organ system -overview, Anatomical position, directional and regional terms, homeostasis and feedback mechanism, cell and tissues and its type and structures, cell physiology, membrane transport and potentials- Classification of skin and body membrane, epithelial, cutaneous, mucous, and connective tissue membrane, integumentary system, hair and hair follicles, nail, infection and allergies

Unit 2: SKELETAL, MUSCULAR AND DIGESTIVE SYSTEM

overview of body bones: skull, vertebrae, and thoracic cage, bones of limbs, joints and its types, structure, classification and functions of bone, anatomy of bone, bone formation, growth and remodelling, bone fracture - types of tissues: epithelial, connective, and muscle and its classifications structure and functions- tissue repairing, development of cells and tissues- anatomy and physiology of digestive system, function of the digestive system, activities if the stomach, large and small intestines

Unit 3: RESPIRATORY, CIRCULATORY AND NERVOUS SYSTEM

Functional anatomy of respiratory system, lung, respiratory physiology, respiratory disorders, developmental aspects of respiratory system- Structure, composition and functions of blood - heart, anatomy of heart, heart valves, physiology of the heart, gross anatomy of blood vessels, physiology of circulation - organization of the nervous system, nervous tissues structure and function, central and peripheral nervous system, autonomous nervous system

Unit 4: REPRODUCTIVE BIOLOGY, URINARY AND ENDOCRINE SYSTEM

Anatomy of the male and female reproductive systems, male reproductive function, female reproductive functions and cycles, pregnancies and embryonic development- physiology and anatomy of kidneys, ureters, urinary bladders, and urethra, fluid electrolyte, acid and base balance-Endocrine system and hormone function - an overview, hormone action, stimuli for control of hormone release, major endocrine organs, other hormone producing tissues

Unit 5: APPLICATIONS OF ANATOMY AND PHYSIOLOGY

Anatomy of skeletal systems: x-ray, and digital x-ray, CT and MRI scan of bones and other organ, measurement of respiratory quotient, heart functions: ECG, Treadmill test, echocardiogram, Cardiac catheterization and angiogram, trans-oesophageal echocardiogram

(TEE) - lung spirometry test – kidney urinalysis, serum creatinine test, blood urea nitrogen (BUN), - nervous system electromyography test, positron emission tomography (PET), and single proton emission (SPECT) scans – hormone blood test.

TEXT BOOKS

1. Marieb. E. N, Keller, S. M. Essentials of Human Anatomy & Physiology, Pearson publishers, 12th edition, 2018.
2. Shier D.N., Butler J.L., Lewis R. - Hole's Human Anatomy and Physiology, McGraw-Hill Education, 15th edition, 2017.
3. David Sturgeon - Introduction to Anatomy and Physiology for healthcare students, Routledge publishers, 1st edition, 2018.
4. Longenbaker, S. Mader's Understanding Human Anatomy and Physiology. McGraw-Hill publishers, 8th edition, 2013

213BIT1103	BIOORGANIC CHEMISTRY	L	T	P	C
		3	0	0	3

Objective(s) To understand the role of biological processes are controlled by underlying chemical principles.

Course Outcome(s)

CO1 Explain the concepts in bonding and stereochemistry

CO2 Explain the different reactions in bioorganic chemistry

CO3 Explain the basic concepts about kinetic method and different mechanism involved

CO4 Describe the catalytic activity and reactivity in bioorganic chemistry

CO5 Describe the interaction between structures and the biological partners.

Mapping of Course Outcomes:

CO / PO/ PSO	PO												PSO		
	1	2	3	4	5	6	7	8	9	10	11	12	1	2	3
CO 1	H	H	M	H	H			H	H				H	H	
CO 2		H		H	H			H	H			H	H	H	
CO 3		H	H	H				H							
CO 4	H	H	H		H			H	H				H	H	
CO 5						H		H		H	H	H	H	H	

UNIT I THE CHEMICAL BOND AND STEREOCHEMISTRY 9 hours

Atoms Electrons and orbitals- Molecular orbital theory - Linear combinations of atomic orbitals, Bonding and nonbonding interactions – Octet rule – types of bonds –ionic and covalent bond - Valence bond theory– sigma and pi bonds - Homonuclear diatomic molecules. Heteronuclear diatomic molecules, structures of polyatomic molecules. Hybridization - sp, sp2 and sp3 hybridization - Conformation analysis - ethane, butane and cyclohexane – Cis-Trans isomerism. Stereochemical activity around the tetrahedral carbon - optical activity - Conformation of the peptide bond.

Unit II MECHANISMS OF SUBSTITUTION AND ADDITION REACTIONS 9 hours

SN1 and SN2 reactions on tetrahedral carbon- nucleophiles- mechanism steric effects – nucleophilic addition on Acetals and ketals -Aldehyde and ketone groups – reactions of carbonyl group with amines- acid catalyzed ester hydrolysis – Saponification of an ester hydrolysis of amides. Ester enolates – claisen condensation – Michael condensation.

UNIT III KINETICS AND MECHANISM 9 hours

Kinetic method – Rate law and mechanism – Transition states- Intermediates – Trapping of intermediates – Microscopic reversibility – Kinetic and thermodynamic reversibility – Isotopes for detecting intermediates. Primary and secondary isotopes – the Arrhenius equation, Eyring equation – ΔG, ΔS, ΔH, Thermodynamics of coupled reactions.

UNIT IV CATALYSIS 9 hours

Reactivity – Coenzymes – Proton transfer – metal ions – Intra molecular reactions – Covalent catalysis – Catalysis by organized aggregates and phases. Inclusion complexation.

UNIT V BIOORGANIC REACTIONS 9 hours

Timing of Bond formation and fission – Acyl group transfer – C-C bond formation and fission – Catalysis of proton transfer reactions – Transfer of hydride ion – Alkyl group. Transfer – Terpene biosynthesis – Merrifield state peptide synthesis – Sanger method for peptide and DNA sequencing.

TEXT BOOKS:

1. Carey, Francis A. Organic Chemistry. 7th Edition, Tata McGraw Hill, 2009.
2. Page, M.I. and Andrew Williams "Organic and Bio-organic Mechanisms". Pearson, 2010.

REFERENCE BOOKS:

1. Dugas, Hermann, Bioorganic Chemistry: A Chemical Approach to Enzyme Action, 3rd Edition, Springer, 2003

213BIT1104	INDUSTRIAL BIOTECHNOLOGY	L	T	P	C
		3	0	0	3

Course objective(s):

To impart knowledge on fermentation process with respect to upstream processing and to understand the concepts of production of primary and secondary metabolites

Course Outcomes:

At the end of the course, students would be able to

CO1: Appreciate the importance of fermentation and screening of microbes of industrial importance

CO2: Explain the medium requirements for fermentation processes

CO3: Compare various types of fermentation processes

CO4: Sketch and describe the production of primary and secondary metabolites

CO5: Discuss the production of microbial enzymes, biofertilizers, biopesticides and modern biotechnological products

Mapping of Course Outcomes:

CO / PO/ PSO	PO												PSO		
	1	2	3	4	5	6	7	8	9	10	11	12	1	2	3
CO1	H		M				M					M	H	H	
CO2	H		M				M					M	H	H	
CO3	H		M				M					M	H	H	
CO4	H		M				M					M	H	H	
CO5	H		M				M					M	H	H	

Unit 1: Introduction to Industrial Bioprocess 9 hours

Introduction to fermentation process - definition, scope, history, microorganisms and industrial products - Screening for microbes of industrial importance - Isolation and preservation of industrial microorganisms - Primary screening (screening for amylase, organic acid, antibiotic, amino acid and vitamin producing microorganisms) and secondary screening - Process flow sheeting- Basic concepts of upstream and downstream processing in bioprocess

Unit 2: Strain Improvement and Media Preparation 9 hours

Methods of strain improvement - inoculum media and inoculum preparation- Medium requirements for fermentation process- Examples of simple and complex media, raw materials, saccharides, starchy and cellulosic materials, nitrogen sources

Unit 3: Fermentation Process 9 hours

Types of fermentation processes - Solid state, surface and submerged fermentations - batch, fed-batch, continuous fermentations - Direct-dual or multiple fermentations - Scale up of fermentations-Process economics

Unit 4: Production of Primary and Secondary Metabolites 9 hours

Fermentative production of alcohol-ethanol, organic acids- citric acid, acetic acid, lactic acid, Aminoacids- glutamic acid, vitamins- vitamin $B_{12,}$ - antibiotics- commercial production of benzyl penicillin and tetracycline- Single cell protein production- Mushroom cultivation

Unit 5: Production of Enzymes and other Biotechnological Products 9 hours

Production and application of industrial enzymes (amylase, protease, lipases) - Microbial biopesticides and biofertilizers, Biopolymers, Biofuels, Recombinant products- Case studies for production of insulin and vaccines

Text Book(s):

1. Wulf Cruger and Anneliese Cruger., A text book of Industrial Microbiology, CBS Publishers & Distributors New Delhi, India 2nd edition, 2016.
2. A.H. Patel., Industrial Microbiology, Laxmi Publications Publishers India, 2nd edition, 2016.

References(s):

1. Prescott and Dunn, Industrial Microbiology, CBS Publishers, New Delhi, 4th Edition, 2005
2. Stanbury, P.F., and Whitaker, A., Principles of Fermentation Technology, Pergamon Press, Oxford, 3rd Edition, 2016.

213BIT1105	PROTEIN SCIENCE AND ENGINEERING	L	T	P	C
		3	0	0	3

Course Objective(s):

To describe the various structural forms of proteins; To understand the functional regulation of proteins and their expression methodologies; To enumerate the various bioinformatics tools and their industrial applications.

Course Outcomes:

After completing this course, the student will be able to:

CO1: Explain and compare the different level of protein structure and their interdependence and protein folding

CO2: Describe the regulation of gene expression control and function of proteins with examples of proton pump and photoreaction center

CO3: Explain the theoretical knowledge of cloning of a gene on expression vector and purification of proteins with various column

CO4: Describe various bioinformatics tools which are involved in phylogenetic analysis, structure and functional prediction of proteins

CO5: Describe the protein engineering techniques how to utilize in industrial biotechnology

Mapping of Course Outcomes:

CO / PO/ PSO	PO												PSO		
	1	2	3	4	5	6	7	8	9	10	11	12	1	2	3
CO1		M	M	M	H	M		M		M			M		
CO2	H	M		M	M	M		M		M	M	M	M		
CO3	H	M		H				H		M	M	M	M		
CO4	H	M			M				M		M		M		
CO5	H	M	M	M			M	H		M	M	H	M		

Unit 1: STRUCTURE OF PROTEINS **9 hours**

Introduction to protein structure – Hierarchy in protein structure - peptide bond, alpha, beta and reverse turn structures - Super secondary structures - alpha-turn-alpha, beta-turn-beta , alpha-beta-alpha and TIM barrel structures - Tertiary structure – architecture of proteins - motif, domains and complex folds, Quaternary structure – complexity and subunit interactions.

Unit 2: ANALYTICAL METHODS **9 hours**

Peptide mapping and sequencing, automated Edman method and mass spec - high throughput protein sequencing setup, Overview of methods to determine 3D structures: XRD and NMR

Unit 3: STRUCTURE - FUNCTION RELATIONSHIP **9 hours**

DNA binding proteins - helix-turn-helix motif – Homeodomain and POU domain – zinc finger – C2C2 and C2H2 – amphipathic helix - leucine zippers and helix – loop - helix - Membrane proteins - General characteristics, trans-membrane segments - Bacteriorhodopsin and photosynthetic reaction center, Serine protease and Ribonuclease

Unit 4: COMPUTATIONAL METHODS **9 hours**

Physical approach – total potential energy and configurational space of the system- Comparative approach – Homology modeling – steps, shortcomings and overall efficiency- Structure prediction, assessments and verification.

Unit 5: ENGINEERING OF PROTEIN **9 hours**

Strategies and approach of protein engineering – *De novo* design, rationale and directed evolution- Stabilization of industrial enzymes by protein engineering – design of ß-glycoside hydrolases – engineering specificity and stability in glucoamylase - Engineering proteins for biosensors

Text Book:

1. Branden, C., Tooze, R., Introduction of Protein structure, Garland, 1st Edition, 1993.
2. Lilia Alberghina., Protein Engineering in Industrial Biotechnology, Harwood Academic publishers, Netherland, Reprint, 2003

Reference(s):

1. Creighton, T.E., Proteins, WH Freeman, New York, 2nd Edition, 1993
2. Voet, D., and Voet, G., Biochemistry, John Wiley and Sons, Singapore, 6rd Edition, 2013.

213BIT1106	FOOD PROCESSING & TECHNOLOGY	L	T	P	C
		3	0	0	3

Course objective(s):

To impart knowledge on fundamental food processing and preservation and to educate quality assurance in food industries

Course Outcomes:

CO1: Outline the main ways in which primary production of food is of importance to food quality.

CO2: Describe the general features and importance of proteins, lipids and carbohydrates in Foods and storage

CO3: Describe the major chemical reactions that occur during food processing

CO4: Identify the beneficial and detrimental roles played by microorganisms in the food Industry.

CO5: Explain the importance of food hygiene and wastages in various processes in food industry

Mapping of Course Outcomes:

CO / PO/ PSO	PO												PSO		
	1	2	3	4	5	6	7	8	9	10	11	12	1	2	3
CO1	H		H	M				H							
CO2	H							H			M		H	H	
CO3	H			M	H			H					H	H	
CO4	H	H		H					M				M	H	M
CO5	H				H			H				H		M	H

Unit 1: Processing of Food and its Importance **9 hours**

Processing of food– cereals, pulses, grains, vegetables and fruits, milk and animal foods, sea weeds, algae, oil seeds & fats, sugars, tea, coffee, cocoa, spices and condiments, additives; need and significance of processing these foods, Important case studies processing of tea and coffee

Unit 2: Methods of Food Handling and Storage **9 hours**

Nature of harvested crop, plant and animal; storage of raw materials and products using low temperature, refrigerated gas storage of foods, gas packed refrigerated foods, Gas atmospheric storage of meat, grains, seeds and flour, roots and tubers; freezing of raw and processed foods.

Unit 3: Large-Scale Food Processing **9 hours**

Milling of grains and pulses; edible oil extraction; Pasteurization of milk and yoghurt; canning and bottling of foods; drying – Traditional and modern methods of drying, Dehydration of fruits, vegetables, milk, animal products etc.; preservation by use of acid, sugar and salt; Pickling and curing with microorganisms, use of salt, and microbial fermentation; frying, baking, extrusion cooking, snack foods; Important case studies in dairy products with reference to chocolate.

Unit 4: Food Microbiology and Food Spoilage **9 hours**

Importance and significance of microorganisms in food science. Types of microorganisms Associated with food, its sources, Utilization of microorganisms in food industries-Genetic manipulations, Fermented Food Products, mycoproteins. Characteristic features, dynamics and significance of spoilage of different groups of foods. Food borne illness: Important case studies in Food borne illness with reference to fermented products

Unit 5: Quality Assurance **9 hours**

Food related hazards – Biological hazards – physical hazards –Food adulteration – definition, common food adulterants, contamination with toxic metals, pesticides and insecticides; Safety in food procurement, storage handling and preparation; Relationship of microbes to sanitation, Public health hazards due to contaminated water and food; Personnel hygiene; sterilization and disinfection of manufacturing plant; use of sanitizers, detergents, heat, chemicals, Cleaning of equipment and premises. Waste disposal-solid and liquid waste; rodent and insect control; use

of pesticides; Important case studies with reference to Food waste disposal-solid and liquid in food pathogenic organism

Text Books

1. Lopez, G.F.G. and Canovas, G.V.B., Food Science and Food Biotechnology, CRC Press, Florida, USA, 2013.
2. Roger, A., Gordan, B., and John, T., Food Biotechnology, Cambridge University Press, USA, 5st Edition, 2014
3. Pelezar, M.I and Reid, R.D., Microbiology, McGraw Hill Book Company, New York, 5th Edition, 2015.
4. James, M.J. Modern Food Microbiology, CBS Publisher, 3rd Edition, 2010.

References

1. George, J. B., Basic Food Microbiology, Springer Verlag, London, 2nd Edition, 1995.
2. James, M. J., Modern Food Microbiology, Springer Verlag, London, 7th Edition, 2006.
3. Frazier, W.C., Westhoff, D.C., Food Microbiology, McGraw-Hill Book Co, New York, 4th Edition, 1988.

213CHE1122	REACTION ENGINEERING FOR BIOTECHNOLOGISTS	L	T	P	C
		3	0	0	3

Course objective(s):

To impart knowledge on reaction kinetics and engineering pertaining to bioprocess

Course Outcomes:

At the end of the course, students would be able to

CO1: Explain the basic knowledge on reaction kinetics.

CO2: Design equations to determine the performance of ideal reactors

CO3: Create various models for describing non- ideal behavior of reactors

CO4: Analyze performance of solid catalyzed reaction systems.

CO5: Describe biochemical reaction systems.

Mapping of Course Outcomes:

CO / PO/ PSO	PO												PSO		
	1	2	3	4	5	6	7	8	9	10	11	12	1	2	3
CO1	H				M								H	H	
CO2				H		M							H	H	
CO3				H		M							H	H	
CO4		H				M							H	H	
CO5	H				M								H	H	

Unit 1: Introduction to chemical reaction Kinetics **9 hours**

Law of mass action, rate equation, elementary, non-elementary reactions and their mechanisms, theories of reaction rate and temperature dependency, analysis of experimental

reactor data, evaluation of rate equation, integral and differential analysis for constant and variable volume system, fitting of data complex reaction mechanism, searching of reaction mechanism

Unit 2: Ideal Reactors **9 hours**

Outline of chemical and biochemical reactors, Isothermal and non-isothermal homogeneous reactor systems, adiabatic reactors, performance equations for single and multiple reactors

Unit 3: Non-Ideal Reactors **9 hours**

Residence time distribution of fluids in vessels, E curve, F curve, RTD in non-ideal flow; non-ideal flow models-one parameter models, conversion in non-ideal reactors

Unit 4: Kinetics of heterogeneous Reaction System **9 hours**

Introduction to heterogeneous (solid catalyzed) reactions, the rate equation for surface kinetics, Pore Diffusion Resistance Combined with Surface Kinetics, Performance Equations for reactors containing porous catalyst particles, design of a adiabatic packed bed system, reactors with suspended solid catalyst: Fluidized reactors.

Unit 5: Biochemical Reaction System **9 hours**

Michaelis-Menten kinetics (M-M Kinetics), kinetics expression for microbial fermentation, substrate limiting microbial fermentation in batch and mixed flow fermenters, product limiting microbial fermentation in batch and mixed flow fermenters.

Text Book (s)

1. Levenspiel, O. Chemical Reaction Engineering- John Wiley- 2009 (3rd Edition)
2. Smith, J.M. Chemical Engineering Kinetics- McGraw-Hill- 1981 (3rd Edition)

Reference (s)

1. Missen, R.W., Mims, C.A. and Saville, B.A. Introduction to chemical reaction engineering and kinetics- John Wiley & Sons- 1998
2. Fogler. H.S. Elements of Chemical reaction engineering- Prentice Hall- 2005 (4th edition)

213CHE1123	MASS TRANSFER	L	T	P	C
		3	0	0	3

Course Outcomes:

At the end of the course, students would be able to

CO1: Solve diffusion and diffusion related problems

CO2: Estimate mass transfer coefficients for gas , liquid contacting systems

CO3: Estimate the number of stages for distillation and absorption column

CO4: Solve problems related to extraction and leaching,

CO5: Explain about adsorption, crystallisation and drying

Mapping of Course Outcomes:

CO/ PO/PSO	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PO 12	PSO 1	PSO 2	PSO 3
CO1		H		M							M		H	H	
CO2		H		M							M		H	H	
CO3		H		M							M		H	H	
CO4		H		M							M		H	H	
CO5	H							M					H	H	

UNIT-1 DIFFUSION

Diffusion, Equation of continuity - Unimolecular diffusion and equimolar counter diffusion applied to both gases and liquids - Diffusion in solids, Knudsen diffusion, measurement of diffusivity of liquids and gases - Empirical relations for measurement of diffusivity of gases and liquids.

UNIT-2 INTERPHASE MASS TRANSFER

Mass transfer coefficients (k type and f-type), overall and local mass transfer coefficients, Lewis Whitman two phase theory, estimation of mass transfer coefficients, analogy between transport processes - Theories of mass transfer - Gas liquid contacting devices – Convective mass transfer.

UNIT-3 VAPOR-LIQUID & GAS-LIQUID OPERATIONS

Vapour liquid equilibria, T-x-y and P-x-y diagrams, steam distillation, flashing, differential distillation, design of continuous counter current distillation process - McCabe Thiele method, (binary components only) - Packed column distillation, HTU, NTU and HETP concepts - Principles of gas absorption, single and multi-component absorption, absorption with chemical reaction, design principles of absorbers, HTU & NTU concepts, industrial absorbers.

UNIT-4 EXTRACTION OPERATIONS

Single stage Liquid - liquid extraction process, equipment and design for liquid-liquid extraction, staged and continuous extraction - Solid-liquid Equilibria -Leaching principles, equipment for solid-liquid leaching, counter current multi stage leaching, extraction of biological materials.

UNIT-5 SOLID - FLUID OPERATIONS

Finishing and polishing of biomaterials, Adsorption equilibria - Batch and fixed bed adsorption - Ion exchange process, Introduction and equipment for crystallisation, crystallisation theory, drying: Mechanism, drying curves, time of drying, batch and continuous dryers.

TEXT BOOKS

1. Treybal, R.E.- Mass Transfer Operations- McGraw Hill, New Delhi- 3rd Edition-1981
2. Geankoplis, C.J.- Transport Processes and Unit Operations- Prentice Hall of India, New Delhi- 3rd Edition- 2002.

REFERENCES

1. Coulson, J.M., Richardson, J.F., Backhurst, J.R., Harker, J.M., Coulson and Richardsons - Chemical Engineering - Volume II - Butter worth Heinemann, Oxford- 5th Edition- 2002.

213BIT2107	CLINICAL BIOCHEMISTRY	L	T	P	C
		3	0	0	3

Course Objectives

The course aims to provide an advanced understanding of the biochemical mechanisms and pathophysiological processes responsible for common biochemical disorders. The course provides an overview of normal and abnormal metabolic functions and the impact of disorders on metabolic processes.

Course Outcomes

After completing this course, the student will be able to:

CO1: Gain knowledge of the basic concepts of clinical biochemistry and biological samples collection procedures.

CO2: Understand the types, clinical manifestations and treatment of Diabetes mellitus and various disorders of carbohydrate metabolic pathways.

CO3: Detail the various types of amino acidurias and nucleic acid metabolism disorders.

CO4: Elaborate the role of serum lipids in diseases and understand the clinical features of atherosclerosis.

CO5: Explain the different types of anaemia and the clinical application of enzymes in diagnosis of clinical disorders by estimating biomarkers in diseases of various organs.

Mapping of Course Outcomes:

CO / PO/ PSO	PO												PSO		
	1	2	3	4	5	6	7	8	9	10	11	12	1	2	3
CO1	H							M					H	H	
CO2	H	M		M		M			M		M		H	M	
CO3	H							M		M			H	M	
CO4	H	M		M		M		M			M		H	M	
CO5	H	M				M				M			H	M	

Unit I Introduction to clinical Biochemistry

The use of biochemical tests, Units and abbreviations used in expressing concentrations and standard solutions. Specimen collection – blood specimens, urine specimen and processing, anti-coagulants and preservatives for blood and urine. Transport of specimens. Sampling errors, Interpretation of results, Reference ranges.

Unit II Disorders of carbohydrate metabolism

Diabetes mellitus-types, diagnosis, clinical manifestations and metabolic alterations. Blood glucose regulation, hypo and hyperglycemia. Glycosuria, galactosemia and fructosuria. Late complications of Diabetes mellitus, glucose tolerance test, Diabetic ketoacidosis. Glycogen storage diseases. Diagnosis and monitoring of Diabetes mellitus.

Unit III Disorders of amino acids and nucleic acid metabolism

Disorders of plasma protein – γ-globulinemia, proteinuria. Uremia, Urecemia and Porphyria. Maple syrup urine disease. Phenylketonuria . Homocystinuria. Tyrosinemia. Inborn errors of amino acid metabolism. Disorders of nucleic acid metabolism - Gout, Lesch – Nhyan syndrome, Von Gierke's disease, hypouricemia, orotic aciduria,

Unit IV Disorders of lipid metabolism

Serum lipids in diseases - cholesterol, lipidosis, triglyceridemia. Hypocholesterolemia and hypercholesterolemia. Hyperlipidaemia and management, Clinical features of atherosclerosis, obesity and fatty liver. Diagnostic test for apo lipoproteins, HDL and LDL cholesterol and triglyceride disorder.

Unit V Hematology and organ function test

Hematology - Anemia and its types – anemia related to shape and size of RBC, anemia due to nutritional deficiencies, hemolytic anemia, hemoglobinopathy and thalassemia. Disorders of blood clotting pathway. Hemophilias. Organ function test- liver diseases (jaundice, hepatitis, Reye's syndrome) and liver function test, renal diseases (glomerulonephritis, nephritic syndrome, urinary tract infection) and renal function test.

Text Books

1. M.N. Chatterjee & Ranashinde, Text Book of Medical Biochemistry. Jaypee Brothers Medical Publisher (P) Ltd. 6th edition (2006).
2. Carl A. Burtis, Edward R. Ashwood and David E. Bruns (eds), Tietz Textbook of Clinical Chemistry and Molecular Diagnosis. 5th edition, 2012.
3. Thomas M. Devlin, Biochemistry with clinical correlation. John Wiley & Sons. 7th Ed, 2010.
4. Allan Gaw, Michael J. Murphy, Rajeev Srivastava, Robert A. Cowan, Denis St. J. O'Reilly, Clinical Biochemistry, 5th edition, 2013.
5. Graham Basten, Introduction to Clinical Biochemistry, Interpreting Blood Results. Book Boon. 2 nd edition, 2011.

213BIT2108	ENVIRONMENTAL BIOTECHNOLOGY	L	T	P	C
		3	0	0	3

Course objective(s):

To familiarize the students with biotechnological interventions related to environment

Course Outcomes:

At the end of this course, students will be able to

CO1: Recognize the fundamentals of environmental microbiology and understand the sources of various environmental pollutants

CO2: Bring out the importance of various bioremediation methods for organic contaminants and toxic metal removal

CO3: List out the pros and cons of the biodegradation methods

CO4: Identify different engineering strategies for bioremediation

CO5: To present an overview of case studies involved pollutant removal and energy generation.

Mapping of Course Outcomes:

CO / PO/ PSO	PO												PSO		
	1	2	3	4	5	6	7	8	9	10	11	12	1	2	3
CO1	H	H	M	H			H								H
CO2	H	M	H			M	H								H
CO3	H	M	H	H			H								M
CO4	H	H	H	H			H								H
CO5	H		M		M		H				H				H

Unit 1: FUNDAMENTALS OF MICROBIAL DIVERSITY AND ENVIRONMENTAL POLLUTANTS 9 hours

General characters, important uses and harmful effects of a) Protozoa b) algae, c) fungi, d) bacteria and e) viruses; Prokaryotes versus eukaryotes- Eukaryotic and Prokaryotic cell structure, three domains of life. Sources and effects of Pollution; Environmental problems-air, water and soil pollution

Unit 2: ENVIRONMENTAL MICROBIOLOGY AND REACTIONS 9 hours

Environment of Soil Microorganisms, Soil Microorganisms Association with Plants; Bioremediation, advantages and disadvantages; In-situ and ex-situ bioremediation; Role of environmental biotechnology in the management of environmental problems, Biotechnology methods for pollution detection - Biosensors

Unit 3: BIOTRANSFORMATION AND BIODEGRADATION 9 hours

Common prejudices against the use of enzymes- Advantages & Disadvantages of Biocatalysts - Isolated Enzymes versus whole cell systems- Mechanistic Aspects and Enzyme Sources, Xenobiotic compounds: Aliphatic, Aromatics, Polyaromatic hydrocarbons, Polycyclic aromatic compounds, Pesticides, Surfactants and microbial treatment of oil pollution

Unit 4: BIOREMEDIATION OF SOIL, WATER AND AIR ENVIRONMENT9 hours

Biotechnologies for Ex-Situ Remediation of Soil, Waste water characteristics - Sewage and waste water treatments systems; Primary, secondary and tertiary treatments- Biological waste water treatment; Slurry bioremediation, phytoremediation of metals in soil, Microbial Degradation of Contaminants in Gas Phase, Biological Filtration Processes for Decontamination of Air Stream

Unit 5: ADVANCES AND CASE STUDIES 9 hours

Biopesticides, Biofertilizers, Biofuels, Bioindicators, Biodegradable plastics, Factors Affecting the Bioremediation Processes, Effects of co-substrates on microorganisms, Phytoremediation, Sequestering Carbon Dioxide, Membrane Bioreactors, Important Case Studies in Environmental Biotechnology: Oil spill, Textile wastewater treatment, Chromium reduction

Textbook(s):

1. McCarty PL - Environmental biotechnology: principles and applications - Tata McGraw-Hill Education – 2012

Reference(s):

1. Mitchell R, Gu J D - Environmental microbiology - John Wiley & Sons – 2010 (2nd Edition)
2. Díaz E - Microbial biodegradation: genomics and molecular biology - Horizon Scientific Press - 2008.

3. Scragg AH - Environmental biotechnology - Essex: Longman - 1999.

213BIT2109	HEALTHCARE BIOTECHNOLOGY	L	T	P	C
		3	0	0	3

Course Objective(s):

To develop knowledge on fundamental aspect of human health care. To motivate the students to investigate the challenging problems in current human diseases. The students would have gained an extensive knowledge about various aspects in biotechnological applications in healthcare industry.

Course Outcome(s):

After completing this course, the student will be able to:

CO1: Differentiate simple proteins and valuable therapeutic proteins

CO2: Explain the production of various recombinant growth hormones

CO3: Describe production and applications of monoclonal antibodies and vaccines

CO4: Understand the mechanism involving in gene therapy

CO5: Discuss the use of antisense oligonucleotides in neurological disorders

Mapping of Course Outcome(s):

CO / PO/ PSO	PO												PSO		
	1	2	3	4	5	6	7	8	9	10	11	12	1	2	3
CO1	H				M				M			H	H		
CO2	H		M		M		H				M			M	M
CO3	H							H					M		M
CO4	H	M		M		H		H		M		M	M		H
CO5	H							H						M	

Unit 1. Simple Proteins and Therapeutic Agents **9 hours**

Proteins as therapeutic agents – Choice of expression systems in therapeutic protein production - Applications, delivery and targeting of therapeutic proteins – Regulatory and safety aspects of therapeutic protein production

Unit 2. Hormones, Recombinant Blood Products & Enzymes as Therapeutic Agents **9 hours**

Insulin, Glucagon, Recombinant human growth hormones - gonadotrophins - haemostasis – Anticoagulants - Thrombolytic agents - Enzymes of therapeutic value - asparaginase - DNAse – glucocerebrosidase – galactosidase - urate oxidase – laronidase - Superoxide dismutase - Debriding agents - Digestive aids

Unit 3. Monoclonal Antibodies & Vaccines **9 hours**

Introduction to monoclonal antibodies – hybridoma - production and purification of monoclonal antibodies - Clinical uses of monoclonal antibodies with case studies –production of recombinant monoclonal antibodies; humanized monoclonal antibodies - inactivated and attenuated vaccines; bacterial polysaccharides, proteins and toxins as vaccines - Recombinant

vaccines- Multivalent vaccine development – Development of different Covid 19 vaccines with proven case studies with special reference to Indian population

Unit 4. Cytokines & Gene Therapy **9 hours**

Interferons- Engineering human interferons -Tumour necrosis factor – interleukins - Haemopoietic growth factors - Gene therapy, delivery systems for gene therapy - Gene therapy in the clinic with case studies

Unit 4. Peptides & antisense oligonucleotides **9 hours**

The nervous system- - Neurological diseases - The use of peptides in the treatment of neurological disease with case studies - Immune responses to peptides - Antisense - Mechanisms of action of antisense molecules - Animal models and oligonucleotides- Clinical trials- towards the next generation of antisense drugs

Text Book(s):

1. Walsh, G., Pharmaceutical Biotechnology: Concepts and Applications, John Wiley & Sons, England, 2007.
2. Ratledge, C., Kristiansen, B., Basic Biotechnology, Cambridge University Press, USA, 2nd Edition, 2001.
3. Gavin, B., Biotechnology in Healthcare: An Introduction to Biopharmaceuticals, Pharmaceutical Press, London, 1998.

Reference(s):

1. Daan J. A., Crommelin, D., Sindelar, B.M., (Eds) Pharmaceutical Biotechnology: Fundamentals and Applications,Springer, 4th Edition, 2013.
2. David, E., Technology and Future of health care, Preparing for the Next 30 years, John Wiley, Singapore, 2nd Edition, 2000.

213BIT2110	ENZYME TECHNOLOGY	L	T	P	C
		3	0	0	3

Course objective(s):

To enhance the understanding of enzymes, their mechanisms, kinetics, purification and characterization

Course Outcomes:

At the end of the course, students would be able to

CO1: Explain the characteristics and catalytic mechanisms of enzymes

CO2: Identify enzyme inhibition patterns and determine kinetics of single substrate enzyme catalyzed reactions

CO3: Extract and characterize enzymes from various sources

CO4: Describe immobilization techniques, and their principles, advantages and disadvantages

CO5: Illustrate the applications of enzymes

Mapping of Course Outcomes:

CO / PO/ PSO	PO												PSO		
	1	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**	**12**	**1**	**2**	**3**
CO1	H	M		M									H	H	
CO2	H	M		M									H	H	
CO3	H	M	M	M			H	M					H	H	
CO4	H		M										H	H	
CO5	H		H			M	H	M					H	H	

Unit 1: Introduction to enzymes and catalysis **9 Hours**

Classification of enzymes -Types of enzymes - constitutive enzyme, induced enzymes, intracellular and extracellular enzymes - Mechanisms of enzyme catalysis and action - concept of active site - Specificity of enzyme action – Concepts of bioenergetics and factors affecting the rate of chemical reactions.

Unit 2: Kinetics of Enzyme Action **9 Hours**

Kinetics of single substrate reactions - Estimation of Michaelis -Menten parameters, Turnover number , Significance of M-M parameters - Multi-substrate reactions, Mechanisms and kinetics - Types of inhibition and Kinetic models - Allosteric regulation of enzymes - Monod-Changeux-Wyman model and Koshland-Nemethy-Filmer model - pH and temperature effect on enzyme activity

Unit 3: Extraction and Purification of enzymes from natural sources **9 Hours**

Extraction of enzymes (soluble enzymes and membrane bound enzymes) from various sources like plant, animal and microbial sources - Nature of extraction medium - Purification of enzyme - Criteria of purity - Determination of molecular weight of enzymes

Unit 4: Enzyme Immobilization **9 Hours**

Physical and chemical techniques for enzyme immobilization - adsorption, matrix entrapment, encapsulation, cross-linking, covalent binding with example - Advantages and disadvantages of different immobilization techniques

Unit 5: Applications of Enzymes **9 Hours**

Applications of enzymes in food, pharmaceutical and other industries-Enzymes for analytical and diagnostic applications, Biosensors applications in industry, healthcare and environment

Text Book(s):

1. Palmer, T., Enzymes: Biochemistry Biotechnology and Clinical Chemistry, East West Press Pvt Ltd, New Delhi, 2nd Edition, 2007.
2. Chaplin, M. and Bucke, C. Enzyme Technology, 1st Edition, Cambridge University Press, London, 1st Edition, 1990.

Reference(s):

1. James Lee, Biochemical Engineering, Prentice-Hall Inc Publishers, Delhi, 1st Edition, 1992

2. Zubay, G., Biochemistry, McGraw Hill Publishers, New Delhi, 3rd Edition, 1999

213BIT2111	AGRICULTURAL BIOTECHNOOGY	L	T	P	C
		3	0	0	3

Course objective(s):
To understand the concepts of genomic markers, crop improvement and pest management with ethical values

Course Outcomes:
At the end of the course, students would be able to
CO1: Understand the agricultural genomics and gene discovery
CO2: Illustrate the metabolic engineering of primary and secondary metabolites
CO3: Describe pest management and control
CO4: Understand the pant genome sequencing and databases
CO5: Illustrate the ethical values and global issues

Mapping of Course Outcomes:

CO / PO/ PSO	PO												PSO		
	1	2	3	4	5	6	7	8	9	10	11	12	1	2	3
CO1		M										H	M		
CO2		M		M						H		H	M	M	
CO3		M		M	H	M		H		H		H			M
CO4	H						H			H	H	H		M	
CO5	H		H		H	M		M		H	H	H			M

Unit 1: Introduction **9 Hours**
History and scope of agricultural biotechnology- maps, markers and comparative genomics, cloning genes by Map-Based approach – dicot and monocot model- Gene discovery by expression analysis- gene discovery from orfeome to phenome

Unit 2: Metabolism in crops **9 Hours**
General strategy for plant metabolic engineering- case studies: engineering of primary metabolic pathways - engineering of primary metabolic pathways - engineering of novel metabolic pathways

Unit 3: Pest Management Biotechnology **9 Hours**
Pest discovery and development – case studies- development of target specific pesticides- pest tolerant genetically modified crops- transgenic insects – improvement of biological control agents

Unit 4: Bioinformatics in Agriculture **9 Hours**
Plant genome initiatives- AGI, TIGR, ESSA, LIS- Plant ontology- plant pathogen genome sequencing- fungal plant pathogen database- agricultural information resources – FAO, AGRIS-AGORA- AGMARKNET

Unit 5: Bioethics and Global issues **9 Hours**

Values of bioethics- Ethical, Logical and Social issues (ELSI) - climatic change –green house effect -global warming – population density- impact on biosphere

Text Book(s):

1. Arthur Germano Fett-Neto - Biotechnology of plant secondary metabolism - Humana Press, Federal University of Rio Grande do Sul Porto Alegre , RS – Brazil – 2016
2. Altman A. and Rita R Colwell - Agricultural biotechnology. CRC Press; 1997

Reference(s):

1. Rajmohan Joshi, Agricultural Biotechnology, Isha Books, 2006.
2. Khalid Rehman Hakeem, Parvaiz Ahmad and Munir Ozturk, Crop Improvement: New Approaches and Modern Techniques, Springer 2013.

213BIT2112	BIOENERGY	L	T	P	C
		3	0	0	3

Course Outcomes:

At the end of the course, students would be able to:

CO1: Analyze the fundamental concepts in bioenergy production.

CO2: Demonstrate the broad concept of second and third generation biofuel production from biomass and other low-cost agri-residues and bio wastes.

CO3: Describe the biomass conversion technologies.

CO4: Identify various microbial resources available for bioenergy production.

CO5: Evaluate the extraction mechanisms available for biofuels and life cycle analysis of biofuels.

Mapping of Course Outcomes:

CO / PO/ PSO	PO												PSO		
	1	2	3	4	5	6	7	8	9	10	11	12	1	2	3
CO1	M	-	H				-	H		H	H				
CO2		M	H				M	-		H	H			H	H
CO3		-	H			M		H		H	H		H	H	H
CO4		H	H			M		H		H	H		H	H	H
CO5		M	H					H		M	H		M	M	

Unit 1: CONCEPTS IN BIOENERGY AND BIOREFINERY **9 hours**

Fundamental concepts in understanding biofuel/bioenergy production, Biopower, Bioheat, Biofuels, Advanced liquid fuels, Biobased products, various biofuels from biomass

Unit 2: BIOMASS FEEDSTOCKS **9 hours**

Feedstock's availability, Characterization and attributes for biofuel/bioenergy production, Renewable feed stocks and their production, Biomass feed stocks: Harvested feed stocks – Feed stocks for first generation Biofuels, Feed stocks for second generation biofuels, Feed stocks for third generation biofuels. Biomass feed stocks: Residue feed stocks - Agricultural waste, forestry waste, farm waste, organic components of residential, commercial, institutional and industrial waste.

Unit 3: BIOMASS CONVERSION TECHNOLOGIES **9 hours**

Biochemical conversion: Hydrolysis, enzyme & acid hydrolysis, Fermentation, Anaerobic digestion, trans-esterification. Enzymatic Conversion; Thermochemical conversion: Combustion, Gasification, Pyrolysis, other thermochemical conversion technologies, Scaling up emerging technologies.

Unit 4: MICROBIAL ENERGY RESOURCES **9 hours**

Bioethanol, biobutanol and biohydrogen from various microbes, fungi and yeast; Photoautotrophic production of ethanol by algae; Extraction of microbial lipids and transesterification into biodiesel; Microbial fuel cells

Unit 5: BIOFUEL EXTRACTION TECHNOLOGIES AND LCA **9 hours**

Ultrasonic extraction, osmotic shock, solvent extraction, Supercritical fluid extraction and extraction using microwave; Life Cycle Analysis of biofuels: Environmental aspects of biofuel utilization, Techno-economic features of bio-fuels

Text book(s):

1. Biorenewable Resources: Engineering New Products from Agriculture–Robert C. Brown–Wiley-Blackwell Publishing, 2003.

2. Twidell., J & Weir., T–Renewable energy resources–Taylor & Francis–2006 (2^{nd} Edition)

References (s):

1. Samir K. Khanal–Anaerobic Biotechnology for Bioenergy Production: Principles and Applications–Wiley-Blackwell Publishing–2008.

2. Luque, R., Camp, J–Hand book of biofuel production processes and technologies, Woodhead publishing ltd–2011 (1^{st} Edition).

213BIT2113	DRUG DESIGN AND DEVELOPMENT	L	T	P	C
		3	0	0	3

Course Objective(s):

The students will learn about various stages of drug development process and the role of computational methods in developing new drugs.

Course Outcomes:

At the end of the course, students would be able to

CO1: Describe the stages in drug discovery and development

CO2: Depict the sources of drugs, screening of natural compounds and compound databases.

CO3: Explain about various drug targets and strategies for rational drug design.
CO4: Explain the use of computation in structure-based and Ligand-based drug design.
CO5: Describe the use of combinatorial chemistry to construct compound libraries and screening them using various computational tools.

Mapping of Course Outcomes:

CO / PO/ PSO	PO												PSO		
	1	2	3	4	5	6	7	8	9	10	11	12	1	2	3
CO1	H	M											M	M	
CO2	H		M	M	M								M	M	M
CO3	H	H	H		H								M	H	
CO4	H	H	H	H	H								H	H	
CO5	H	M	H	H	H							M	H	H	

Unit 1: Introduction to Drug Discovery and Development 9 hours

Drug Discovery and Development stages, Sources of Drugs- Natural sources, Organic synthesis, Prokaryotic and Eukaryotic Cells as bio-factories, Pharmacology- Basics of Pharmacokinetics and Pharmacodynamics

Unit 2: Approaches to new Drug Discovery 9 hours

Rational basis of Drug Design, New approaches for lead identification - Using Disease Models as Screens for New Drug leads, Developing bioassays for drug screening, High Throughput Screening, Lead optimization approaches - Conformation restriction, Pharmacophore, Metabolic stabilization, ADME-Tox profiling

Unit 3: Enzymes and Receptors as Targets of Drug Design 9 hours

Enzyme catalytic principles- Lock and Key and Induced fit theory, Types of enzyme inhibition, Rational design of enzyme inhibitors, affinity labels, Suicide inhibitors, transition state mimicry, Illustrative examples - ACE, renin and HIV protease inhibitors, Receptor theory, Molecular Biology of receptors, Receptor Binding Assays, Lead Compound Discovery of Receptor agonists and antagonists, Illustrative examples- Adenosine receptor agonists and antagonists

Unit 4: Computer Aided Drug Design 9 hours

Virtual Screening, CADD approaches, Structure based drug design: Molecular Docking – Force field Calculation, Energy minimization, Scoring methods in docking, Ligand based drug design: QSAR and Pharmacophore modeling, Molecular Dynamics

Unit 5: Current Status and Future Prospects 9 hours

Combinatorial chemistry, Combinatorial synthesis and compound libraries, peptidomimetics, Peptide libraries- Peptide libraries through phage display; synthetic vaccine design, Biomarkers and Disease models

Text Books

1. Larsen, P.K, Liljefors, T and Madsen U – Text Book of Drug Design and Discovery – Taylor and Francis – 2016 (5rd Edition).

Reference

1. Perun, T. J. and Propst, C. L – Computer Aided Drug Design – Marcel Dekker Inc., 1989 (1st Edition).
2. Scolnick, E.M – Advances in Protein Chemistry, Vol 56, Drug Discovery and Design – Academic Press, London – 2001.
3. Walsh, G – Biopharmaceuticals-Biochemistry and Biotechnology – Wiley – 2003 (2nd Edition).

213BIT2114	INFECTIOUS DISEASES	L	T	P	C
		3	0	0	3

Course objective(s):

At the end of the course student will be understand the major infectious diseases in human.

Course Outcomes:

At the end of the course, students would be able to,

CO1: Explain the mode of transmission of infectious diseases

CO2: Discuss various types of bacterial causing diseases

CO3: Explain the mechanism of viral pathogenesis

CO4: Describe the epidemiology and clinical manifestation of parasitic diseases

CO5: Discuss current methods used for detection of infectious diseases.

Mapping of Course Outcome(s):

CO / PO/ PSO	PO												PSO		
	1	2	3	4	5	6	7	8	9	10	11	12	1	2	3
CO1		H	H				H				H			M	
CO2		H	H		H		H				H				
CO3	H	H	H			H	H					H		M	
CO4	M	M	H		M		H				H				
CO5			H		M		M				M				M

Unit 1: Transmission of Infectious diseases: 9 hours

Pathogen entry into the human body: portals of entry and portals of exit, modes of transmission (contact, vehicles, vectors) adhesion, colonization & invasion - spread of disease in populations pathogenic actions of bacteria (tissue destruction, toxins, immunopathogenesis) -mechanisms for escaping host defenses- Epidemiology of infectious diseases.

Unit 2: Bacterial causing diseases: 9 hours

Gram-Positive *cocci –Staphylococcus aureus* (cutaneous infections, food poisoning, endocarditis, toxic shock syndrome - *Streptococcus pyogenes* (pharyngitis, impetigo, erysipelas, rheumatic fever, etc.), *Streptococcus pneumonia.* Gram-Positive *bacilli- Bacillus anthracis (anthrax), Listeria monocytogenes (neonatal diseases, etc.), Corynebacterium*

diphtheriae (diphtheria), Clostridium perfringens (gas gangrene, food poisoning, etc.), Clostridium tetani (tetanus), Clostridium botulinum (botulism), Clostridium difficile (gastroenteritis), Erysipelothrix rhusiopathiae (erysipeloid). Gram-Negative *Bacilli-Salmonella* (gastroenteritis, enteric fevers, etc.), *Shigella* (shigellosis), *Campylobacter* (gastroenteritis), *Helicobacter* (gastritis, gastric & duodenal ulcers).

Unit 3: Mechanisms of Viral Pathogenesis: 9 hours

Acquisition & infection of target tissue, cytopathogenesis (lytic & nonlytic infections, oncogenic viruses), human host defenses against viral infection, immunopathology, epidemiology of viral diseases, (age, immune status & other host factors), control of viral spread

Unit 4: Fungal and Parasitic Diseases: 9 hours

Fungal diseases: Trichophyton- Nocardia- Candida- Histoplasma., Opportunistic fungal pathogen- *Aspergillus* - human parasitic diseases - Malaria- Filariasis- Leishmaniasis- identification- Immune reactions– pathology of infections- vectors of transmission.

Unit 5: Diagnosis of Infectious diseases: 9 hours

Specimen collection and processing -Test performance – Laboratory-Developed Tests in Molecular Diagnostics- Verification of Molecular Assays -Standards and Standardization of Molecular Diagnostics - New therapeutic strategies for emerging infectious diseases- Clinical manifestations, treatment, prevention and control.

Text Books

1**.** Kenrad E. Nelson & Carolyn Masters Williams. *Infectious Disease Epidemiology: Theory and Practice.* Second Edition, Jones and Bartlett Publishers, 2008 (2nd Edition).

2. Medical Microbiology, A Guide to Microbial Infections: Pathogenesis, Immunity, Laboratory Diagnosis, and Control, Greenwood, Slack, and Peutherer (Eds.), Churchill Livingstone; ISBN: 0443- 07077-6, 2002 (16th Ed).

References

1. Medical Microbiology & Immunology: Examination & Board Review Levinson and Jawetz, Lange Medical Books/McGraw Hill; ISBN: 0-07-138217-8, 2020 (16th Edition)
2. Buckingham, L., Molecular Diagnostics: Fundamentals, Methods & Clinical Applications, F. A. Davis Company, Philadelphia. 2012 (2nd Edition)
3. Harald H. Kessler Molecular Diagnostics of Infectious Diseases, 1st Edition, Walter de Gruyter GmbH & Co. KG, Berlin/New York. 2014 (3rd Edition)

213BIT3115	ANIMAL BIOTECHNOLOGY	L	T	P	C
		3	0	0	3

Course objective(s):

To enhance the knowledge on animal cell culture, engineering of animal cells and manipulation techniques with reference to live stock

Course Outcomes:

At the end of the course, students would be able to

CO1: Understand animal cell culture media and animal cell culture techniques

CO2: Describe expression vectors, gene transfer methods and production of recombinant products using animal cells

CO3: Apply embryonic methods for basic research to improve animal and human healthcare

CO4: Apply reproduction methods with particular reference to gamete and embryo manipulation techniques, production of transgenic animals and cloning

CO5: Design strategies to manipulate for improvement of livestock production

Mapping of Course Outcome(s):

CO / PO/ PSO	**PO**												**PSO**		
	1	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**	**12**	**1**	**2**	**3**
CO1	M											H	H		
CO2	M				M									H	
CO3	H	H	M	H										H	H
CO4	H	H		H							M			H	
CO5	H	H	H			M					M			H	

Unit 1: Animal Cell Culture **9 hours**

Fundamentals of cell culture – differences between bacterial culture and animal cell culture. Media for culturing cells - Chemically defined and serum free media for cell culture; Surface Sterilization of various equipment and apparatus - Animal cells and stem cells - culture and growth conditions; types and methods of development of cell lines; Characterization, Maintenance and Preservation of animal cells – Scaling up of animal cell cultures, Advances in cell culture – Co-culture and 3D cultures.

Unit 2: Gene Transfer Methods **9 hours**

Gene transfer methods - Chemical and physical methods. Virus mediated methods; Biology and Construction of viral vectors like SV40, adenovirus, lentivirus, vaccinia virus, herpes virus, and adeno associated virus, baculovirus – Transfection methods; stable and transient methods, Protein production by genetically engineered mammalian cell lines,

Unit 3: Micromanipulation of Embryo's and Embryo Transfer **9 hours**

Micromanipulation technology; Artificial insemination, Superovulation, Embryo transfer, In vitro fertilization - Pregnancy diagnosis - Sexing of embryos, Embryo splitting; Cryopreservation of embryo - Breeding of farm animals

Unit 4: Transgenic Animals **9 hours**

Concepts of transgenic animal technology - Various strategies for the production of transgenic animals and their importance in biotechnology; pronuclear microinjection, embryonic stem cells and somatic cell nuclear transfer in the production of transgenic animals (Eg: Dolly, cloned sheep) - iPS technology - Transgenic animals as bioreactors for producing

pharmaceutically important compounds and therapeutics etc. Role of gene knock-out and gene knock-in mice model for studying human genetic disorder.

Unit 5: Applications **9 hours**

Manipulation of Growth hormone; Somatotropic hormone and Thyroid hormone - Probiotics as growth promoters; Ideal characteristics of probiotics; Mode of action and uses of probiotics- Manipulation of lactation - Lactogenesis- galactopoiesis, wool growth and rumen microbial digestive system.

Text Books

1. Davis D - Animal Biotechnology - National Academic Press - 2002 (1st Edition).
2. Singh B, Gautam SK and Chauhan MS - Textbook of Biotechnology - Pearson Education - 2012 (1st Edition).
3. Ramadoss P - Animal Biotechnology: Recent Concepts and Developments - MJb Publishers - 2008 (1st Edition).

References

1. Freshney RI - Culture of Animal Cells: A manual of Basic technique - John–Wiley and sons - 2010 (6th Edition).
2. Masters JRW - Animal Cell Culture: Practical Approach - Oxford University Press - 2000 (3rd Edition).
3. Holland A and Johnson A - Animal Biotechnology and Ethics - Springer Verlag - 1998 (1st Edition).
4. Jenkins N - Animal Cell Biotechnology - Humana Press - 1999 (1st Edition).
5. Verma A and Singh A - Animal Biotechnology - National Academic Press - 2013 (1st Edition).

213BIT3116	PLANT BIOTECHNOLOGY	L	T	P	C
		3	0	0	3

Course objective(s):

Make students to understand photosynthesis in prokaryotes and eukaryotes and breakdown of glucose in plants; learning how to apply tissue culture to get transformants and secondary metabolites. Train them to understand the difference between plant breeding and genetic engineering and their applications.

Course Outcomes:

After completing this course, the student will be able to:

CO1: Understanding the architecture of plant cell and its major biochemical pathways in synthesis and release of ATP molecules

CO: 2 Analyze the production of commercially important compounds using plant tissue culture and understanding the significance of micropropagation

CO: 3 Evaluating the plant breeding and genetic engineering approaches

CO: 4 Analyze the application of plant genetic engineering and advantages of creation of BT cotton and golden rice

CO: 5 Understanding the concept of molecular farming, the plant genome organization and editing the genome by technology

Mapping of Course Outcomes:

CO / PO/ PSO	PO												PSO		
	1	2	3	4	5	6	7	8	9	10	11	12	1	2	3
CO1	M												M	H	
CO2	M	H	H	H	M						L	M	H	H	
CO3	M	H	H		H		M				H	M	H	M	
CO4	M	H	H	H	H	M	M	M				M	H	H	
CO5	M	H	M		H	M	M				L	H	H	H	

Unit 1: Plant Biology and Major Pathways **9 Hours**

Photosynthetic bacteria and Blue-green Algae; autotrophs, heterotrophs. Special features and organization of plant cells, Biological significance of plant organelles and parts. Photosynthesis: generation of ATP and synthesis of glucose; Mitochondria and breakdown of glucose into ATP.

Unit 2: Plant Tissue Culture **9 Hours**

Plasticity and totipotency, Plant cell culture media, Plant growth regulators, Organogenesis Culture types: Callus, cell-suspension culture, protoplasts, root culture, hairy root culture and production of secondary metabolites, Plant regeneration by somatic embryogenesis: Direct and Indirect. Case study: Rice regeneration via somatic embryogenesis; Micropropagation of banana

Unit 3: Plant Breeding and Plant Transformation **9 hours**

Simple and complex inheritance, Molecular Markers: PCR based AFLP, SSR and SNP markers, Marker-Assisted selection, Hybrid seeds production. *Agrobacterium* biology and T-DNA transfer, Binary vector system, *Agrobacterium*-mediated plant transformation, Direct DNA transfer methods in plants - particle bombardment method.

Unit 4: Applications of Plant Genetic Engineering **9 hours**

Herbicide tolerant plants: Different strategies to achieve, strategy to generate glyphosate tolerant plants and their related problems. Mechanism of insecticidal crystal protein of *Bacillus thuringiensis*, strategy to generate BT cotton transgenic plants; their problems and solutions. Disease resistance: against bacterial, fungal and viral pathogens, gene silencing, applications in virus resistance and generation of transgenic golden rice. Case study for Gene silencing: Generation of Transgenic papaya plants against the Papaya Ring spot virus.

Unit 5: Molecular Pharming and Plant Genomes **9 hours**

Molecular farming of proteins, Plant vaccines, custom-made plantibodies, case study: bioplastics. Plant genome size and organization: Arabidopsis genome sequencing project and genome editing by CRISPR technology: Case study of genome editing in plants to generate virus-resistant plants.

Text Books:

1. Neal Stewart, Jr - Plant Biotechnology and Genetics: Principles, Techniques, and Applications - John Wiley & Sons Inc. USA - 2016 (2nd Edition)
2. Slater A., Nigel W., Scott, and Fowler MR - Plant biotechnology: The Genetic Manipulation of Plants - Oxford University Press, London - 2008 (2nd Edition)
3. Arthur Germano Fett-Neto - Biotechnology of plant secondary metabolism - Humana Press, Federal University of Rio Grande do Sul Porto Alegre , RS – Brazil – 2016

Reference:

1. Khalid Rehman Hakeem, Parvaiz Ahmad and Munir Ozturk - Crop Improvement: New Approaches and Modern Techniques – Springer 2013.

213BIT3117	IPR IN BIOTECHNOLOGY	L	T	P	C
		3	0	0	3

Course objective(s):

To promote self- learning of Intellectual Property Rights (IPR) and its applications in biotechnology

Course Outcomes:

CO 1: Advanced skills in establishment of Intellectual Property Rights (IPR).
CO 2: Good skills in patent claim writing and analysis, presentations of and negotiations regarding IPR.
CO 3: Development of biotechnology in various fields
CO 4: Identify problems in biotechnology using case studies.
CO 5: Use of biotechnology in business

Mapping of Course Outcomes:

CO / PO/ PSO	PO												PSO		
	1	2	3	4	5	6	7	8	9	10	11	12	1	2	3
CO1					M	M		M		H		H			
CO2					M			M		H		H			
CO3	M	H	H	H	M			M		H		H	M	L	
CO4					M	M		M		H		H	M	L	
CO5					M			H		H		H	M	L	

Unit I: Introduction to IPR **9 hours**

Invention and creativity, Intellectual Property (IP) and its need, Types of IP: patents, Trademarks, Trade secrets, copyright & related rights, industrial design, traditional knowledge, geographical indications, Plant Breeder rights - importance - Protection of IPR International trademark Law; TRIPS

Unit II: Fundamentals of Patenting **9 hours**

Basics of Patents; Requisites and criteria for filing IPRs; Patent search and publications; How to draft patent applications; National and International procedures, obligations and implications; Licensing and infringements, unfair competition

Unit III: IPR in Biotechnology **9 hours**

Nutraceuticals, Pharmaceuticals, Bioprocess Engineering; Technology in genetic manipulations of cells and organisms; Development of crop varieties, transgenic plants and animals; Bioremediation, biopesticides, enzymes, vaccines, diagnostic tests, bioinformatics; Bioinstrumentation and Biosensor

Unit IV: Recent trends in IPR **9 hours**

Stories of Pasteur, Chakrabarti and Leder; Bioprospecting and biopiracy (Neem, Turmeric, Basmati, Novartis patent case etc.,) Constructive utilization of traditional knowledge systems, PGR, IGF, UPOV;

Unit V: IPR in Biobusiness **9 hours**

Types of bio businesses; Amount of money and the equations involved; Successes, failures and reasons; Entrepreneurship; Social psyche that governs markets and investments; Business culture; Pertinent legislations, global sharing of technology, Ever-greening chain.

Text Book

1. Kshitij Kumar Singh - Biotechnology and Intellectual Property Rights - Springer India - 2015 (1st Edition)

References

1. Carlos C - Trade Related aspects of IPR, a Commentary on TRIPS agreement - Oxford University Press, USA, 2007 (1st Edition).
2. Cornish WR - Intellectual Property- Patent, Copyright Trademarks and Allied rights, Sweet and Maxwell, USA - 2003 (5th Revised Edition).

213BIT3118	BIOREACTOR DESIGN AND ANALYSIS	L	T	P	C
		3	0	0	3

Course objective(s):

To gain understanding of kinetics of biochemical reactions, design, analysis and scale up of bioreactors

Course Outcomes:

At the end of the course, students would be able to

CO1: Describe the kinetics of biochemical reactions

CO2: Design equations to determine the performance of ideal reactors and describe the non-ideal behavior of bioreactors

CO3: Design equations for different types of bioreactors

CO4: Understand the mechanical design of bioreactors

CO5: Analyze the scale up criteria of bioreactors

Mapping of Course Outcomes:

CO / PO/ PSO	PO												PSO		
	1	2	3	4	5	6	7	8	9	10	11	12	1	2	3
CO1	H	M											H	H	M
CO2	H	M		H		M							H	H	M
CO3	H	M		H	M	M							H	H	
CO4	H	M		H	M	M							H	H	
CO5	H	M		H	M								H	H	

Unit 1: Design Principles **9 hours**

Principles and kinetics of chemical and biochemical reactions - Fundamentals of homogeneous reactions for batch, plug flow, semi-batch, stirred tank/ mixed reactors, Energy and mass balances in biological reaction modeling- Types of bioreactors and their configurations, Classification based on Schuegerl, Kafarov components of bioreactors and their operation.

Unit 2: Ideal and Non-Ideal Reactors **9 hours**

Reactors based on flow characteristics- ideal and non-ideal bioreactors- Design of ideal reactors- Process design and operation of bioreactors, operational modes of reactors – batch, continuous, fed batch, repetitive batch, recycle and continuous cultivation, Stability analysis of bioreactors- Regime analysis

Unit 3: Design of Bioreactor **9 hours**

Batch reactor analysis for kinetics (synchronous growth and its application in product production)- Design and analysis of fed batch systems and CSTRs- Concepts of dilution rate and productivity analysis in CSTR- Enzyme catalyzed reactions in CSTRs - CSTR reactors with Recycle and Wall growth - multistage chemostat- Ideal Plug- Flow Tubular reactor.

Unit 4: Selection of Bioprocess Equipment (Upstream and Downstream) **9 hours**

Vessel, agitation system materials, welds, finish, valves, piping and valves for biotechnology, special requirements of utilities and cleaning of production plants. Specifications of bioprocess equipment; Mechanical design of reactors, heat transfer and mass transfer equipment; Design considerations for maintaining sterility of process streams and process equipment; Piping and instrumentation; Materials of construction for bioprocess plants. Computational data acquisition in bioprocess

Unit 5: Bioreactor Scale-Up **9 hours**

Scale up and scale down issues: Effect of scale on oxygenation, mixing, sterilization, pH, temperature, inoculums development, nutrient availability and supply; Bioreactor scale-up based on constant power consumption per volume, mixing time, impeller tip speed (shear), mass transfer coefficients. Scale up of downstream processes: Adsorption (LUB method); Chromatography (constant resolution etc.); Filtration (constant resistance etc.); Centrifugation (equivalent times etc.); Extractors (geometry based rules). Scale-down related aspects.

Text Book (s)

1. Robert H. Perry and Don W. Green. - Perry's Chemical Engineers' Handbook - McGraw Hill Book Co.- 2008 (8th Edition)
2. Octave A. Levenspiel - Chemical Reaction Engineering- Wiley- Interscience Publication - 2004 (3rd Edition)

Reference (s)

1. Shuler, M.L. and Kargi, F. - Bioprocess Engineering-Basic Concepts - Prentice Hall Pvt. Ltd., New Delhi – 2006 (2nd Edition)
2. Roger G. Harrison, Paul W. Todd, Scott R. Rudge, and Demetri P. Petrides - Bioseparations Science and Engineering - Oxford University Press – 2010 (3rd Edition)

213BIT3119	BIOSENSORS	L	T	P	C
		3	0	0	3

Course objective(s):

To provide basic concepts in design of biosensor and its applications

Course Outcomes:

At the end of the course, students would be able to

CO1: Understand the basic concepts of biosensors

CO2: Compare various types of biosensors

CO3: Apply immobilization techniques

CO4: Analyze multi analytes

CO5: Illustrate various applications of biosensors

Mapping of Course Outcomes:

CO / PO/ PSO	PO												PSO		
	1	2	3	4	5	6	7	8	9	10	11	12	1	2	3
CO1	H								M			H	H	H	
CO2	H	M	M									M	H	H	H
CO3	H		M		H							M		H	
CO4	H	H	H	H								H			
CO5	H	H			H				H			H		H	H

Unit 1: Introduction to Biosensors **9 hours**

Definitions, , types of sensors, target analytes, various recognition, signals, and device types, history of field -course overview, class survey, definitions, motivation, biological inspiration.

Unit 2: Recognition / Transduction **9 hours**

Enzyme sensors-affinity sensors: antibodies, oligo-nucleotides measuring binding in affinity sensors, SPR, quartz crystal microbalance, FRET-membrane protein sensors: ion channels, receptor -whole cell sensors – bacteria, yeast, mammalian cells

Unit 3: Immobilization **9 hours**

Immobilization: adsorption, encapsulation - (hydro-gel, sol-gel glass, etc.), covalent attachment, diffusion issues -optical fiber sensors, planar wave-guides

Unit 4: Device Integration **9 hours**

Micro-scale and nanoscale: BioMEMS, nanowires, quantum dots, magnetic beads, PEBBLE sensors measuring complex samples, multi-analyte detection, continuous measurements, reagentless biosensors

Unit 5: Applications **9 hours**

Agricultural, food safety, food processing : state of the field, market potential, unique design criteria and needs, current sensors in use biomedical applications, bio-security, environmental : state of the field, market potential, unique design criteria and needs, current sensors in use.

Text Books

1. Bilitewski, U. and Turner, A.P.F. - Biosensors for Environmental Monitoring - Harwood Academic Publishers, The Netherlands - 2000.
2. Ligler, F.S. and Rowe Taitt, C.A. - Optical Biosensors: Present & Future. Elsevier, The Netherlands - 2002.

Reference

1. Yang, V.C. and T.T. Ngo., - Biosensors and Their Applications- Kluwer Academic/Plenum Publishers, New York, NY - ISBN: 0-306-46087-4 - 2000.

213BIT3120	MOLECULAR DIAGNOSTICS AND THERAPEUTICS	L	T	P	C
		3	0	0	3

Course objective(s):

To gain knowledge on development of diagnostic techniques and therapeutics for various diseases and disorders

Course Outcomes:

At the end of the course, students would be able to,

CO1: Explain the molecular techniques for the analysis of Genetic and Neurological disorders.

CO2: Discuss the role of proteins in diagnostic techniques.

CO3: Recognize the importance of antibodies based diagnosis

CO4: Apply genetic engineering tools in disease diagnosis.

CO5: Discuss current methods used for production of recombinant proteins and vaccines.

Mapping of Course Outcome(s):

CO / PO/ PSO	PO												PSO		
	1	2	3	4	5	6	7	8	9	10	11	12	1	2	3
CO1		H	H				H				H				
CO2		H	H		H		H				H			M	
CO3	H	H	H			H	H					H		H	
CO4	M	M	H		M		H				H				M
CO5			H		M		M				M				

Unit 1: Molecular Diagnosis of Disorders **9 hours**

Biochemical disorders; immune, genetic and Neurological disorders - molecular techniques for the analysis of these disorders -assays for the diagnosis of inherited diseases- Bioinformatic tools for molecular diagnosis.

Unit 2: Proteins in Diagnostic Techniques **9 hours**

Isolation of proteins and other molecules associated with disease - Process and their profiling for diagnosis. Analysis of diseases associated proteins: 2D analysis; mass spectrometry; protein micro array; ethics in molecular diagnosis

Unit 3: Antibody Based Diagnosis **9 hours**

Monoclonal antibodies as diagnostic reagents - production of monoclonal antibodies with potential for diagnosis- diagnosis of bacterial, viral and parasitic diseases by using ELISA and Western blot.

Unit 4: Therapeutic Agents **9 hours**

Recombinant growth hormones- Applications, delivery and targeting of therapeutic proteins - engineering human interferons and growth hormones –Gene therapy –Liposome mediated targeted drug delivery- Antisense therapy.

Unit 5: Vaccines **9 hours**

Bacterial polysaccharides, proteins and toxins as vaccines - subunit, attenuated and vector vaccines - Multivalent vaccine development against different diseases - Commercial and regulatory aspects of vaccine production and its distribution.

Text Books

1. Glick BR and Pasternak JJ - Molecular Biotechnology: Principles and Applications of Recombinant DNA - ASM Press, Washington - 2017 (5^{th} Edition).

References

1. Andrew Read and Dian Donnai - New Clinical Genetics, A Guide to genomic medicine Scion Publishing Ltd, Oxfordshire, UK - 2020 (4^{th} Edition).
2. James W Goding - Monoclonal antibodies: Principles and Practice - Academic Press - 2010 (3^{rd} Edition).
3. Campbell MA and Heyer LJ - Discovering Genomics, Proteomics and Bioinformatics - Pearson/Benzamin Cummings, San Francisco, USA - 2007 (2^{nd} Edition).

213BIT3121	RADIATION BIOLOGY	L	T	P	C
		3	0	0	3

Course Objective(s):

To inculcate basic knowledge on the effects of radiations and their various biological applications. The students would gain an extensive skill in radiation oncology and radio-therapy for medical applications.

Course Outcome(s):

After completing this course, the student will be able to:

CO1: Describe the concept involving in radiation biology
CO2: Differentiate the molecular and cellular effects of radiation
CO3: Understand the mechanisms of radiation protection
CO4: Explain the basic concepts in radiation oncology
CO5: Know the application of radiotherapy

Mapping of Course Outcome(s):

CO / PO/ PSO	PO												PSO		
	1	2	3	4	5	6	7	8	9	10	11	12	1	2	3
CO1	H									H				L	
CO2		M			M							M		L	
CO3				H		H			H		M			L	
CO4	H		M					M						L	
CO5														L	

Unit 1. Introduction to Radiation Biology
Physics and chemistry of radiation interactions with matter – source and Types of ionizing radiation - Particulate radiations - Linear Energy Transfer and Relative Biologic Effectiveness- Radiation dose and units - Principles of radiation dosimetry - Direct and indirect effects.

Unit 2. Molecular and Cellular Radiobiology
Radiation lesions in DNA - DNA Strand Breaks and Chromosomal Aberrations - Cell Survival Curves – Radio-sensitivity and Cell Age in the Mitotic Cycle - Consequences of unrepaired DNA damage: chromosome damage - Repair of Radiation Damage and the Dose Rate Effect - Relative biological effectiveness (RBE) - Cellular repair exemplified in survival curves - Cellular hyper-radiosensitivity (HRS) and induced repair (IRR) - Other molecular targets: bystander (epigenetic) effects – Molecular techniques.

Unit 3. Radiobiological Basis of Radiation Protection
Radiation accidents and environmental radiation exposure with suitable case studies - Long term radiation risks from low radiation doses - Diagnosis and medical management of radiation syndromes - Radiation carcinogenesis - Heritable radiation effects - Effects on the developing embryo - system for radiation protection

Unit 4. Radiation Oncology
In vitro and *in vivo* assays for cell survival - Repair of radiation damage - Tumor biology and host/tumor interactions - Radiobiology of normal tissue damage - Time-dose-fractionation - Predictive assays in different populations applications

Unit 5. Radiotherapy
Doses and Risks in Diagnostic Radiology with suitable case studies, Interventional Radiology and Cardiology and Nuclear Medicine - Clinical Response of Normal Tissues - Tumor Model System - Cell, Tissue, and Tumor Kinetics - Time, dose, and fractionation in Radiotherapy- Combined radiation and drug treatments - Clinical radiobiology of common cancers with applications - Second cancers in radiotherapy patients with suitable case studies.

Text Book(s):

1. Radiation biology: A handbook for teachers and students, Training course series no. 42, International Atomic Energy Agency (IAEA), Vienna, 2010.
2. Eric J. Hall and Amato J. Giaccia., Radiobiology for the Radiologist, Lippincott, Williams and Wilkins, 6th Edition, 2006.

Reference(s):

1. A.H.W. Nias, An Introduction to Radiobiology, Second Edition, John Wiley and Sons, 1998.

213BIT3122	CLINICAL TRIALS AND MANAGEMENT	L	T	P	C
		3	0	0	3

Course Objective(s):

To develop skills in important aspects of developing new drugs, biologics and devices. This course helps to understand good clinical practice and regulation in clinical trials. To understand about protocol, feasibility, documentation and activity studies.

Course Outcomes:

At the end of the course, students would be able to

CO1: Illustrate the concept of new drug and medical device development process

CO2: Interpret the principles and regulations on good clinical practice and able to outline the roles and responsibilities of different authorities in clinical research.

CO3: Summarize the various components of a protocol and to explain various documentation systems in clinical research.

CO4: Analyze various levels of clinical trial data management.

CO5: Outline on various international clinical trials and its impact on society.

Mapping of Course Outcomes:

CO / PO/ PSO	PO												PSO		
	1	2	3	4	5	6	7	8	9	10	11	12	1	2	3
CO1		H						H			M		L	L	L
CO2								H	M				L	L	L
CO3			M		M			H		H		H	L	L	
CO4	H							H					L		
CO5								H					L		L

Unit 1: Developing New Drugs, Biologics and Devices **9 hours**

History of Clinical Trials – Nuremberg Trials, Thalidomide Incident, Sulfanilamide tragedy, Tuskeegee syphilis study - Nuremberg code – Declaration of Helsinki - Belmont Report - The Drug Development Process - Pre-Clinical Studies - Clinical Trial Phases - Application to Market New Drugs and Biologics - FDA Review Groups - Developing New Devices - Pharmacovigilance - Medwatch

Unit 2: Good Clinical Practice and the Regulations **9 hours**

ICH GCP Guidelines - Local Laws –- Roles and Responsibilities: Principal Investigator, Sponsor, Monitor, Pharmacist, Study Nurse, Volunteers - Informed Consent and the Regulations - Institutional Review Boards - Monitoring, Audits, and Inspections

Unit 3: Protocol, Feasibility and Activity Studies, and Documentation **9 hours**

Common Components of a Protocol - Study Organization - Objectives/Endpoints - Study Design - Study Population and treatment plan - Statistical Aspects - Monitoring - Reviewing a Specific Protocol - Study Start-up Phase - Study Maintenance Phase - Study Completion and Close-Out Phase - Maintaining Site Study File- Management of Study Drugs, Biologics, and Devices - HIPAA, the Privacy Rule, and Clinical Trial Data

Unit 4: Managing Clinical Trial Data **9 hours**

Guidelines and Regulations Regarding Clinical Trial Data - Study Site Responsibilities Regarding Clinical Trial Data - Source Document Verification of Clinical Trial Data – Electronic Data Capture and Virtual trials - Documents at Study Start-Up - Documents While the Study is in Progress - Documents at Study Close-out - Trial Endpoints - Endpoint Adjudication

Unit 5: Global Health and International Trials **9 hours**

International Clinical Trials - Ethnic and Racial Differences - Ethical Issues and Cultural Sensitivities - ALCOA-C Checklist–– Schedule Y – CTRI – CRO vs SMO – Indian trial Regulations – Adverse Event Reporting

Text Book(s):

1. Liu, M.B. and Davis, K., Clinical trials manual from the Duke Clinical Research Institute: lessons from a horse named Jim., John Wiley & Sons, Ltd., 2nd Edition, 2010.
2. Wang, Duolao, and Ameet Bakhai. Clinical trials: a practical guide to design, analysis, and reporting. Remedica, 2006.

Reference(s):

1. Gallin, J.I. and Ognibene, F.P. Principles and Practice of Clinical Research, Academic Press.3rd Edition, 2012.
2. Friedman, Lawrence M., et al. *Fundamentals of clinical trials*. springer, 2015.
3. Brody, Tom. Clinical trials: study design, endpoints and biomarkers, drug safety, and FDA and ICH guidelines. Academic press, 2016.
4. Dan Sfera and Chris Sauber. The Comprehensive Guide To Clinical Research: A Practical Handbook For Gaining Insight Into The Clinical Research Industry, 2019.

213BIT3123	BIOMATERIALS	L	T	P	C
		3	0	0	3

Course objective(s):

To understand the fundamental concepts of various materials and imaging techniques used in biological systems

Course Outcomes:

CO1 Describe the fundamental concepts of functional materials in biological system.
CO2 Explain the characterization studies of material used for biological system.
CO3 Summarize the Basic concept of micro and macro imaging techniques.
CO4 Describe the process and implications of molecular imaging.
CO5 Discuss the various types of bio imaging techniques involved in disease diagnosis.

Mapping of Course Outcomes:

CO / PO/ PSO	PO												PSO		
	1	2	3	4	5	6	7	8	9	10	11	12	1	2	3
CO1	H			M									H		
CO2	H	H												M	
CO3	H						H								
CO4	M						H								
CO5	H	M					H						H		

Unit 1: Functional Materials in Biology **9 hours**

Introduction to Biomaterials- Bio mineralization- Molecular Self-assembly- Nanomaterials, Synthetic and naturally derived biomaterials - Organic and inorganic polymers –Proteins-Polysaccharides - Composite biomaterials–Nanobiomaterials -Clinical applications, Decellularization - Hydrogels -Tissue engineering - Regenerative medicine - Biodegradable materials.

Unit 2: Materials Characterization **9 hours**

Fourier transform Infrared spectroscopy (FTIR) – Ultraviolet and visible spectroscopy (UV-Vis) – Thermo gravimetric Analysis (TGA) – Differential Thermal Analysis (DTA) – Differential Scanning Calorimetry (DSC).

Unit 3: Basic Concepts in Bio Imaging **9 hours**

Fundamentals of macro and micro imaging, Basics of fluorescence and their labeling procedure to acquire biological signals, fluorophores, chromophores, Molecular probes, contrast agents in molecular imaging.

Unit 4: Molecular Imaging **9 hours**

Introduction to Molecular Imaging- Bio structures of Interest in Molecular Imaging (MI): Cells & Tissues - Information molecules & other bio-molecules of interest in MI. Implication of molecular imaging in radiology – medicine - surgery and biomaterial research - Processes Involved in MI: Optical properties of cell, tissues & molecules.

Unit 5: Imaging Techniques **9 hours**

Basics and techniques of X-ray, CT, PET, MRI, Ultrasound Imaging, digital X-ray, fMRI and Thermography

Textbooks

1. N. Malsch- Biomedical nanotechnology- CRC press- 1999.

2. M. Arumugam - Biomedical Instrumentation – 2009 (Second Edition)

References

1. Buddy D. Ratner, Allan S. Hoffman, Frederick J. Schoen, Jack E. Lemons- Biomaterials Science: An Introduction to Materials in Medicine - Academic Press- 2004
2. J.B. Park and J.D. Bronzino - Biomaterials: Principles and Applications- CRC Press- 2002.
3. John G. Webster. - Medical Instrumentation Application and Design – 2009 (Fourth Edition)
4. Nester, Anderson, Roberts, Pearsall, Nester - Microbiology: A Human Perspective- McGraw-Hill – 2001 (3rd Edition)

213BIT3124	ENTREPRENEURSHIP IN BIOTECHNOLOGY	L	T	P	C
		3	0	0	3

Course objective(s):

Enabling students to understand available opportunities for entrepreneurship and innovation and development of required skills would be the targets.

Course Outcomes:

After completing this course, the student will be able to:

CO1: Understand the qualities needed for a successful entrepreneur
CO2: Convert a new idea into a business proposal and be familiar with finance management
CO3: Realize market demands in current biotechnology industry and future
CO4: Analyze the possible sources of funding to start a Company
CO5: Follow the legal procedures, ethics and protect their intellectual property rights

Mapping of Course Outcomes:

CO / PO/ PSO	PO												PSO		
	1	2	3	4	5	6	7	8	9	10	11	12	1	2	3
CO1	M	H								H			L		
CO2	M	H	H	M		M			H	H	H	M			
CO3	M	H	H	M		M			H	H		M	L		L
CO4		M	M	H	M	M			H	H	M	M			
CO5	M	M	M		M	H		H		H		M	L		L

Unit 1: Qualities of an Entrepreneur **9 Hours**

Entrepreneur, Creativity & Entrepreneurial personality and Entrepreneurship in Biotechnology, pillars of bio-entrepreneurship and major start-ups in Biotechnology, Concept and theories of Entrepreneurship, Entrepreneurial traits and motivation, Nature and importance of Entrepreneurs-Case study on successful entrepreneurs in India.

Unit 2: Idea into a Project and Finance **9 Hours**

Project identification, project formulation, project design and writing project report. Investment process, Break even analysis, profitability analysis and budget planning process. Case studies on successful entrepreneur ideas of recent times.

Unit 3: Emerging Industries **9 Hours**

New drug development, Development of new agricultural product, Stem cell research, Tissue engineering, Soil test, Organic Farming, Bio fertilizers, Vermicomposting, Integrated Farming. Contract Research Organization (CRO) Services, marketing or consultancy services and Environmental biotechnology; Life cycle of a biotechnology company, Case studies of successful and unsuccessful businesses

Unit 4: Funding and Support **9 Hours**

Overview of startup finances and Sources of Investment: Venture Capital funding, Angel investors - Sources of funds for entrepreneurs and their equity distribution. Government schemes for commercialization of technology (Biotech Consortium India Limited), Association of Biotechnology Led Enterprises – (ABLE)-Case study on Indian funding agencies for entrepreneurship.

Unit 5: Setting up bio-business **9 Hours**

Start-up: Setting of a small-scale industry, location of an enterprise, steps in starting small-scale industry, Incentive & subsidies for industry, Problems of entrepreneurship, The art of negotiation, Workable marketing and the strength of distribution-Opportunities and lessons in international marketing-Case study on the milestones of Biocon.

Text Books:

1. Craig Shimasaki - Biotechnology Entrepreneurship: Starting, Managing, and Leading Biotech Companies – Elsevier Academic Press USA – 2014
2. Richard Dana Ono- The Business of Biotechnology: From the Bench of the Street: Butterworth- Heinemann Publications USA – 1991
3. Milind Antani and Gowree Gokhale - Contract research and manufacturing services (CRAMS) in India - Woodhead Publishing Series in Biomedicine, India - 2012

Reference:

1. Kshitij Kumar Singh - Biotechnology and Intellectual Property Rights: Legal and Social Implications - Springer India - 2015

213BIT3125	STEM CELL TECHNOLOGY	L	T	P	C
		3	0	0	3

Course objective(s):
To impart self-learning of basics of stem cell technology

Course Outcomes
CO1: Describe the types of stem cells and their properties
CO2: Classify different types of stem cells
CO3: Illustrate embryonic and adult stem cells
CO3: Understand gene therapy and applications of stem cells
CO4: Study the ethical controversies and legal issues upon commercialization

Mapping of Course Outcomes:

CO / PO/ PSO	PO												PSO		
	1	2	3	4	5	6	7	8	9	10	11	12	1	2	3
CO1	H							M							
CO2	H				M			M							
CO3	H	M			M			M						M	
CO4	H	M		H	H			H		M				H	
CO5	H	M		H	M			M		H	H	H			

Unit 1: INTRODUCTION **9 hours**
Stem Cells - Properties- Stem Cell Plasticity, Regulators of Pluripotency and Differentiation of Stem Cell, Differences Between Adult and Embryonic Stem Cells.

Unit 2: CLASSIFICATION OF STEM CELLS **9 hours**
Hematopoietic stem cells-Embryonic Stem Cells, Germ Line Stem Cells and Neural Stem Cells-Adult cardiac stem cells -Epithelial stem cells - bone marrow stromal stem cells -Neural stem cells –stem cell cancer induction.

Unit 3: EMBRYONIC AND ADULT STEM CELLS **9 hours**
Culturing of embryos-isolation of human embryonic stem cells – blastocyst – inner cell mass – properties of ES cells. Somatic stem cells - adult stem cell differentiation – trans differentiation – plasticity – different types of adult stem cells. iPS technology.

Unit 4: TREATMENT AND ENGINEERING OF STEM CELLS **9 hours**
Gene therapy – genetically engineered stem cells – stem cells and Animal cloning – transgenic animals and stem cells – Therapeutic applications HLA typing- Alzheimer's disease –tissue engineering application – production of complete organ - kidney – eyes - heart – brain, iPS for treatment. Case study on cardiac repair using iPS.

Unit 5: STEM CELL RESEARCH AND ISSUES **9 hours**

Establishment of human stem cell bank- Commercialization of human stem cells -Recent ethical controversies about embryonic stem cell research and legal issues. Legal issues with stem cell applications. Case study on successful treatment of disease by using stem cells.

TEXT BOOKS:

1. Stem cells Handbook–Editor: Stewart Sell–Humana Press–Oct.2003
2. Stem cell and future of regenerative medicine–By committee on the Biological and Biomedical applications of Stem cell Research–National Academic press–2002
3. Stem Cell Biology–Editors: Daniel R.Marshak, Richard L. gardner and David Gottlieb Cold Spring Harbor Laboratory Press–Cold Spring Harbor NY USA–2001

REFERENCE BOOKS

1. Robert F. Almeder–Stem cell research-Humana press–2004.
2. Jennifer Viegas–Stem cell research–The Rosen publishing group–2003
3. Adult stem cells–Editor:Kursad Turksen–Humana Press–Jan 2004
4. Human Embryonic stem cells–Editors: Arlene Chiu, Mahendra S.Rao, Huamna Press–2003

213BIT3126	CELL CULTURE TECHNOLOGIES	L	T	P	C
		3	0	0	3

Course objective(s):

To understand the basics and applications of animal cell culture

Course Outcomes

CO1: Fundamental understanding of animal cell culture
CO2: Understand the functions and use of equipments in animal cell culture
CO3: Understand the difference between primary and secondary cell culture
CO4: Describe the isolation of specialized cells, propagation, and analysis
CO5: Understand the cell culture assays and its applications

Mapping of Course Outcomes:

CO / PO/ PSO	PO												PSO		
	1	2	3	4	5	6	7	8	9	10	11	12	1	2	3
CO1															
CO2					M			M						M	
CO3		M			M			M							
CO4		M			M			M		M		M			M
CO5		M			M			M		M		M		M	

Unit I: Introduction & Biology of cultured cells **9 hours**

History of Cell and Tissue Culture, Different types of culture; Ethical Issues; Established Cell Lines, the culture environment – Cell adhesion, Cell proliferation, differentiation, cell signaling, senescence; Transformation and Immortalization

Unit II: Equipments, aseptic techniques and media development **9 hours**

Equipments of cell culture laboratory; Culture vessels – substrate, Treated surfaces, Contamination – Sources, Types and monitoring; Elements of aseptic environment – work surface, personal hygiene, reagents and media, cultures, sterile handling; Development of media – Physiochemical parameters, Balanced Salt solutions, Complete media, Serum; Conditioned medium; Serum free media

Unit III: Primary and Secondary Cell Culture **9 hours**

Primary cell culture and its methods, Secondary Cell culture; Subculturing – Adherent cells and Non – Adherent cells, Cell separation; Characterization of cell lines; Maintenance of cell culture; Cryopreservation; Quantization; Freezing and thawing cells

Unit IV: Specialized cell culture techniques **9 hours**

Culture of specialized cells – Epithelial cells, Mesenchymal cells, Neuroectodermal cells, Hematopoietic cells, Stem Cells; Culture of tumor cells; Organotypic cultures

Unit V: Cell culture Assays and Applications **9 hours**

Cytotoxicity; Cell viability; Assays on cell proliferation – MTT assay, XTT Assay, Sulforhodamine B Assay; Applications of cytotoxicity assays; Scale up of Cell culture; Applications of cell lines – Cancer research, Gene therapy, Immunological studies, Vaccine Production, Drug selection and improvement.

Text Book

1. Freshney, R. Ian. Culture of animal cells: a manual of basic technique and specialized applications. John Wiley & Sons, 2015.

References

1. Jenkins, Nigel, ed. *Animal cell biotechnology: methods and protocols*. Vol. 8. Clifton, NJ: Humana Press, 1999.
2. Helgason, Cheryl D., and Cindy L. Miller. Basic cell culture protocols. Totowa, NJ.: Humana Press, 2005.
3. Mather, Jennie P., and Penelope E. Roberts. Introduction to cell and tissue culture: theory and technique. Springer Science & Business Media, 1998.
4. Butler, Michael. *Animal cell culture and technology*. Taylor & Francis, 2004.
5. Verma, Anju. "Animal tissue culture: Principles and applications." Animal Biotechnology. Academic Press, 2014. 211-231.

213BIT3127	EVOLUTIONARY BIOLOGY	L	T	P	C
		3	0	0	3

Course Objective(s):
To describe origin of life, isolation, speciation, adaptation of evolutionary process and explain how to evolve the higher order living things

Course Outcomes:
At the end of the course, students would be able to
CO1: List the key component involved in the origin of life and explain their mechanisms.
CO2: Demonstrate various mutational theories and how to isolate new origin from the ancestors
CO3: Explain and illustrate how species are evolved through evolutionary process
CO4: Discuss the mechanism of adaptation and distribution in evolutions
CO5: Explain importance and various applications phylogeny and mutational process

Mapping of Course Outcomes:

CO / PO/ PSO	PO												PSO		
	1	2	3	4	5	6	7	8	9	10	11	12	1	2	3
CO6	H	H	H	H	H	H		M	M	H		M		M	M
CO7	H	M	M			M	M				M				M
CO8	M			M		M		M	H					M	
CO9	H	H					H			M	H	M	H	M	
CO10			M	M		M		M				M	H	M	M

UNIT 1: ORIGIN OF LIFE
Introduction to evolution; origin of earth, chemical origin of life, biological experimental evidences for the chemical origin of life, origin of prokaryotes and eukaryotes - homologous and analogus organs, vestigial organs, connecting links, embryological and palaeontological evidences, physiological and biochemical evidences, Urey and Miller's Experiment, geological time scale, Lamarckism, Neo-Lamarckism, Darwinism, Neo-Darwinism

UNIT 2: ISOLATION
Mutation theory of De vries, modern synthetic theory of evolution, natural selection, directional and disruptive selection, variation, genetic variability; Isolation - geographical, reproductive, ecological, seasonal, and ethological isolation, physiological isolation, hybrid sterility isolation, Hardy -Weinberg equilibrium, gene pool, gene frequency, species and species concepts,

UNIT 3: SPECIATION
Species and speciation, true speciation, phyletic speciation, allopatric speciation, sympatric speciation, parapatric speciation, peripatric speciation, quantum speciation, genetic drift, mimicry, mimicry and evolution, colouration and evolution

UNIT 4: ADAPTATION, DISTRIBUTION AND MOLECULAR EVOLUTION

Adaptations, adaptive and neutral evolution, cursorial, fossorial, arboreal, Volant, desert, and cave adaptations, evolution, ancestor and salient features of man, salient features of apes, difference between apes and mans, trends in human evolution, evolution of an as seen in the fossil record, animal distribution, biogeography, zoogeography, palaearctic region, nearctic region, neotropical region, ethiopian region, oriental region, australian region - Mutational processes, evolution of mutation rates, evolution of DNA sequences, the molecular clock, selection and genetic drift on the molecular level, polymorphism and SNPs.

UNIT 5: APPLICATIONS OF EVOLUTIONARY BIOLOGY

Phylogenetic trees and other models, optimality criteria for selecting phylogenetic hypothesis, Substitution models for DNA and other data types. Super trees, consensus trees, tree compatibility. Algorithms for evaluating the tree space; Markov Chain Monte Carlo, genetic algorithms, Evaluation of results from phylogenetic analyses, phylogenetic dating

Text Books

1. S. Parker, Evolution: The Whole Story, Thames & Hudson publishers, 1st Edition, 2015
2. M. P. Muehlenbein, Human Evolutionary Biology, Cambridge University Press; 1st edition, 2010
3. D. J. Emlen, Carl Zimmer, Evolution, Roberts publishers, 1st edition, 2020
4. Jonathan Bard, Principles of Evolution: Systems, Species, and the History of Life, Garland Science; 1st edition, 2016

213BIT3128	TISSUE ENGINEERING	L	T	P	C
		3	0	0	3

Course objective(s):

At the end of the course student have understanding of the applications of tissue engineering.

Course Outcomes:

At the end of the course, students would be able to,

CO1: Explain the basic concept of tissue engineering

CO2: Discuss various types of tissues and components in tissue engineering

CO3: Explain the basic biology of stem cells.

CO4: Describe the importance of biomaterials and its applications

CO5: Discuss currently available tissue engineered therapies for various diseases.

Mapping of Course Outcome(s):

CO / PO/ PSO	PO												PSO		
	1	2	3	4	5	6	7	8	9	10	11	12	1	2	3
CO1		H	H				H				H		H	M	
CO2		H	H				H				H		H	H	
CO3	H	H	H			H	H					H	H	M	
CO4	M	M	H		M		H				H		H	M	
CO5			H		M		M				M		H	M	

Unit I Introduction to tissue engineering: 9 hours

Basic definition; current scope of development; use in therapeutics, cells as therapeutic agents, cell numbers and growth rates, measurement of cell characteristics morphology,number viability, motility and functions. Measurement of tissue characteristics, appearance, cellular component, ECM component, mechanical measurements and physical properties.

Unit II Tissue architecture 9 hours

Tissue types and Tissue components, Tissue repair, Engineering wound healing and sequence of events. Basic wound healing Applications of growth factors: VEGF/angiogenesis, Basic properties, Cell-Matrix & Cell-Cell Interactions, telomeres and Self-renewal, Control of cell migration in tissue engineering.

Unit III Basic biology of Stem cells 9 hours

Stem Cells : Introduction, hematopoietic differentiation pathway Potency and plasticity of stem cells, sources, embryonic stem cells, hematopoietic and mesenchymal stem cells, Stem Cell markers, FACS analysis, Differentiation, Stem cell systems- Liver, neuronal stem cells, Types & sources of stem cell with characteristics: embryonic, adult, haematopoietic, fetal, cord blood, placenta, bone marrow, primordial germ cells, cancer stem cells induced pleuripotent stem cells.

Unit IV Biomaterials 9 hours

Biomaterials: Properties of biomaterials, Surface, bulk, mechanical and biological properties. Scaffolds & tissue engineering, Types of biomaterials, biological and synthetic materials, Biopolymers, Applications of biomaterials in tissue engineering.

Unit V Clinical applications 9 hours

Stem cell therapy, Molecular therapy, In vitro organogenesis, Neurodegenerative diseases, spinal cord injury, heart disease, diabetes, burns and skin ulcers, muscular dystrophy, orthopaedic applications, Stem cells and Gene therapy Physiological models, tissue engineered therapies.

TEXT BOOKS

1. Bikramijit Basu., Biomaterials Science and Tissue Engineering: Principles and Methods. Cambridge University Press; 2017 (1st edition)

2. Meyer, U.; Meyer, Th.; Handschel, J.; Wiesmann, H.P. Fundamentals of Tissue Engineering and Regenerative Medicine.2009 (1st edition)

REFERENCES

1. Robert A Brown, Extreme Tissue Engineering: Concepts and Strategies for Tissue Fabrication, Wiley Blackwell 2013.

2. R. Lanza, I. Weissman, J. Thomson, and R. Pedersen, Handbook of Stem Cells Academic Press 2012 (2nd Edition)

3. J. J. Mao, G. Vunjak-Novakovic *et al* (Eds), Translational Approaches In Tissue Engineering & Regenrative Medicine" Artech House, INC Publications. 2008 (1st Edition)

HONORS COURSES

217BIT1101	ANALYTICAL TECHNIQUES IN BIOTECHNOLOGY	L	T	P	C
		3	0	0	3

Course Objective(s):

To introduce the theoretical and practical aspects of analytical techniques in biotechnology, this is the back bone for the basics of Downstream Processing.

Course Outcomes:

After completing this course, the student will be able to:

CO1: Describe the working principles of pH meter, pH indicator and estimation of macromolecules

CO2: Explain the principles and instrumentation of colorimetry and spectroscopy

CO3: Describe the principles and instrumentation of centrifugation methods

CO4: Classify electrophoretic separation methods

CO5: Understand the principles and instrumentation of chromatography methods

Mapping of Course Outcomes:

CO / PO/ PSO	PO												PSO		
	1	2	3	4	5	6	7	8	9	10	11	12	1	2	3
CO1	S				M				M					L	
CO2	S				M				M				H	M	
CO3				S	M				M				H	H	L
CO4	S				M				M				H	H	M
CO5	S				M							M	H	H	M

Unit 1: Basic Techniques

pH - formulae for pH; Measurement of pH- pH indicators, pH Meter: Nernst's equation and measuring scheme, titration of acids and bases; Buffer solution, buffer capacity, buffers for biological and clinical measurements. Estimation of macromolecules- carbohydrates (Anthrone), proteins (Lowry, Bradford) and lipids (Bligh and Dyer).

Unit 2: Colorimetry and Spectroscopy

Beer-Lambert's Law; Colorimetry: Principles, classification of methods of colour measurement, standard curve method, calibration graph method. Principle, instrumentation and applications of Visible light spectroscopy, Ultraviolet spectroscopy, Atomic absorption spectroscopy, Fluorescence spectroscopy, Circular dichroism spectroscopy, FTIR spectroscopy, NMR spectroscopy.

Unit 3: Centrifugation

Basic principles of centrifugation; Sedimentation velocity and Sedimentation equilibrium; Types of rotors; Principle, instrumentation and applications of centrifuges: Ultracentrifuge,

Preparative and analytical centrifuge: Differential centrifugation, Density gradient centrifugation: Rate zonal centrifugation, Isopycnic centrifugation.

Unit 4: Electrophoresis

Basic theory and applications of electrophoresis; Principle, instrumentation and applications of Agarose electrophoresis, Polyacrylamide electrophoresis, Native gel electrophoresis, Gradient electrophoresis, Capillary electrophoresis, Immunoelectrophoresis, 2D- gel electrophoresis, Pulse-field gel electrophoresis, blotting techniques- Southern, Northern and Western blot.

Unit 5: Chromatographic Methods of Separation

Introduction to chromatography - Principle, instrumentation and applications of column chromatography: Size-exclusion chromatography, Ion-exchange chromatography, Affinity chromatography; Principle, instrumentation and applications of TLC, HPLC and GLC. Separation of amino acids and lipids.

Text Book:

1. Wilson and Walker- Principles and Techniques of Biochemistry and Molecular Biology-2018 (8^{th} edition) ISBN: 9781316614761

2. D. Freifelder - Physical biochemistry: Applications to Biochemistry and Molecular Biology-Macmillan-1984 (2^{nd} Edition) - ISBN 10: 0716714442 ISBN 13: 9780716714446.

Reference:

1. O.M. Griffith - Techniques of preparative, zonal and continuous flow ultracentrifugation - Beckman Instruments, Spinco Division, Applications Research Department- 1986 (5^{th} Edition) – ISBN OL14852412M.\

217BIT1102	**BIOPHYSICS**	**L**	**T**	**P**	**C**
		3	**0**	**0**	**3**

Course Outcomes:

At the end of the course, students would be able to

CO1: To understand the basic properties of water in relation with the living system

CO2: Physical properties of cell membrane and associated proteins

CO3: Study the electrical properties involved in signaling

CO4: Exploitation of bioelectricity for understanding the functions of organs

CO5: Utilization of radiations for biomedical research

Mapping of Course Outcomes:

CO / PO/ PSO	PO												PSO		
	1	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**	**12**	**1**	**2**	**3**
CO1		M		M	M			M					M		
CO2		M		M	M			M						M	
CO3		M		M	M			M							
CO4		M		M	M			H							
CO5		H	M					H						H	

Unit 1: Water **9 hours**

Interaction of Water with Macromolecules - Ions in Aqueous Solutions, Debye–Huckel Radius - Intermolecular Interactions - Structure of Proteins- Protein Folding and Protein Dynamics, Energy of Activation, Theory of Absolute Reaction Rate

Unit 2: Cell Membrane **9 hours**

Composition & properties of cell membrane, Transport through membrane, Permeability coefficient and partition coefficient, Body fluids, Electrolytes, Ampholytes in Solution, Acid & Base balance, Blood Viscosity and Newtonian nature, colloids, filtration, diffusion, osmosis, dialysis, ultrafiltration, ultracentrifugation, cellular fractionation, electrophoresis, plasmapherosis,

Unit 3: Bioelectricity **9 hours**

Bioelectricity: Membrane Potential, Local and propagator types, Diffusion potential, phase boundary potentials, Generator Potentials, compound Action Potentials(AP),Propagation of AP, factors influencing propagation of AP, biosignal and types, Electrical properties of excitable membranes, Membrane capacitance, Resistance, conductance, dielectric properties of membrane, space and time constant for excitable membrane, equivalent electrical circuit diagram for excitable membranes and neural membranes.

Unit 4: Applications of Bioelectricity **9 hours**

Electrical stimulus & Biophysical activity: Stimuli, Receptor potential, pacemaker potential, Strength & duration relationship, skin impedance, total body impedance, impedances at high frequencies, patient safety, electrical shock and hazards, leakage current, Electrical activity of brain (EEG), different wave forms & their characteristics, Electrical activity of heart (ECG), waveform and significance, Electrical activity of muscles (EMG) and muscletone, Electro& RetinoGram (ERG), Electro& Occologram (EOG)

Unit 5: Radiations **9 hours**

Radioactivity: Ionizing radiations, U&V & I&R radiations, Product ion of radioisotopes & their use in biomedical research, Radioactive decays, Half-life period, radioimmunoassay, Photochemical reaction, law of photo chemistry, fluorescence and phosphorescence.

Text book(s):

1. Glaser, R–Biophysics–Springer-Verlag–Germany–2005 (5th edition)
2. Wood, A. W., Physiology–Biophysics and Biomedical Engineering–CRC press–2012 (1st edition)

Reference(s):

1. Alpen, E. L–Radiation Biophysics–Academic Press–1998 (2nd edition)
2. Narayanan, P–Essentials of Biophysics–Anshan Publishers–2009 (1st Edition)

217BIT1103	NANOBIOTECHNOLOGY	L	T	P	C
		3	0	0	3

Objective(s)	To develop skills in important aspects of nanomaterials characterization. To understand about advantages of fabrication techniques. To know about various applications in medical fields.
Course Outcome(s)	
CO1	Explain the synthesis and characterization of the nanomaterials
CO2	Describe fabrication and its advantages
CO3	Identify the tools available for cellular manipulation and detection
CO4	Differentiate various application in medical fields
CO5	Describe the impact of nanobiotechnology

Mapping of Course Outcome(s):

CO / PO/ PSO	**PO**												**PSO**		
	1	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**	**12**	**1**	**2**	**3**
CO 1	H	H	M	H	H			H	H					M	
CO 2		H		H	H			H	H			H		M	
CO 3		H	H	H				H						H	
CO 4	H	H	H		H			H	H					H	
CO 5						H		H		H	H	H		H	

Unit 1: Synthesis and Characterization **9 Hours**

Scope of Nanobiotechnology – Examples and production of various types of nanostructured materials with usage and potential within biotechnology –Polysaccharides-proteins – microorganisms- plant - Optical -UV-Vis/Fluorescence - FTIR-X-ray diffraction – Imaging and size -Electron microscopy- Zetapotential- EDAX.

Unit 2: Nano-Fabrication **9 Hours**

Conjugation of biomolecules with nanoparticles-polysaccharides, protein, metal ions (Ag, Au, Cu, Se, Zn), Molecular prints of biomolecules– Electron beam lithography for biological applications – Laser direct –Electrospinning of nanofibers

Unit 3: Biomolecular, Cellular Manipulation and Detection **9 Hours**

Atomic force microscopy –Dielectrophoresis –Lab in chip-Nanofluidics- Optical tweezers – Cellular response to nanoscale features –Micro and nanotechnologies in integrative biology

Unit 4: Applications of Nanotechnology **9 Hours**

Micro-and Nanotechnology in tissue engineering –Nanotechnology in targeted drug delivery– Lipid based nanoparticles for siRNA delivery –nanodiamonds for bioimaging and therapeutic applications- Biomedical micro probe for super resolved image extraction

Unit 5: Impacts of Nanobiotechnology **9 Hours**

Nanotoxicity: cytotoxicity, environmental toxicity and genotoxicity - in vitro and in vivo assays - animal models of toxicity testing

Text Book(s):

1. Yubing, X. (Eds.) The Nanobiotechnology Handbook, CRC Press, 2013.

2. Clad, A.M. and Christof, M.N. (Eds.). Nanobiotechnology II: More concepts and applications, Wiley-VCH Verlag GmbH & Co. KGaA, Weinheim, 2007.

Reference(s):

1. Stergios, L. (Eds.) Nanomedicine and Nanobiotechnology, Springer-Verlag Berlin Heidelberg, 2012.

217BIT2104	METABOLIC ENGINEERING	L	T	P	C
		3	0	0	3

Course objective(s)

To understand the overview of metabolic pathways, methods and analysis in metabolic engineering

Course Outcomes

At the end of the course, students would be able to

CO1: State the role of transport processes in metabolic pathways and material balance

CO2: Describe the regulation of enzymes involved in metabolic pathways

CO3: Explain metabolic flux analysis and its role in manipulation of metabolite production.

CO4: Determination of metabolic fluxes

CO5: Employ various strategies to manipulate the production of industrially important metabolites

Mapping of Course Outcomes:

CO / PO/ PSO	PO												PSO		
	1	2	3	4	5	6	7	8	9	10	11	12	1	2	3
CO1	H	M											H	H	
CO2	H											M	H	H	
CO3		H				M	M	M					M	M	M
CO4		M		H	H								M	M	M
CO5		M			H		H						H	H	

Unit 1: Review of Cellular Metabolism and Material Balance 9 hours

Transport processes; Active and Passive transport, Facilitated diffusion - Fueling reactions; Glycolysis, TCA, fermentative pathways etc - Biosynthetic reactions; Biosynthesis of amino acids, nucleic acids, fatty acids and other building blocks - Polymerization - Growth energetic - Black Box model - Elemental balances and Heat balance

Unit 2: Regulation of Metabolic Pathways 9 hours

Enzyme kinetics; Mechanisms and their dynamic representation - Regulation of enzyme activity versus regulation of enzyme concentration - Regulation of metabolic networks - Regulation of at the whole cell level - Regulation of metabolic networks - Example of important pathways - Case studies and analytical type problem

Unit 3: Metabolic Flux Analysis 9 hours

Building stoichiometric matrix; Steady state and pseudo steady state assumptions Metabolic flux analysis –Overdetermined systems - Underdetermined systems; Using different optimizing functions to solve linear programming problem - Sensitivity analysis ; understanding flux cone and constraints; Introducing additional constraints from thermodynamics

Unit 4: Experimental determination of metabolic fluxes 9 hours

C13 labeling, NMR and GC-based methods for flux determination- Applications of metabolic flux analysis; aminoacid production - Example: Glutamic acid production etc.

Unit 5: Industrial applications 9 hours

Examples of pathway manipulation - Enhancement of product yield and productivity - Extension of substrate range - Extension product spectrum and novel products - Improvement of cellular properties - Xenobiotic degradation

Text Book(s)

1. Gregory N. Stephanopoulos, Aristos A. Aristidou–Metabolic engineering: Principles and Methodologies–Jens Nielsen Academic Press–1998 (1st Edition)
2. Christina D. Smolke–The Metabolic Pathway Engineering Handbook: Fundamentals, CRC Press, New York, London–2010 (1st Edition)
3. Cortassa S., Aon M.A., Iglesias A.A and LioydD–An Introduction to Metabolic and Cellular Engineering, World Scientific Publishing Co., Singapore–2011(2ndEdition)
4. Sang Yup Lee and Eleftherios T. Papoutsakis–Metabolic Engineering, CRC Press, New York–1999 (1st Edition)

Reference(s)

1. Wang.D.I.C Cooney C.L., Demain A.L., Dunnil.P. Humphrey A.E. Lilly M.D–Fermentation and Enzyme Technology, John Wiley and sons–1980.
2. Stanbury P.F and Whitaker A–Principles of Fermentation Technology–Elsevier Press–2013 (3rd Edition)
3. Zubay G., Biochemistry–Macmillan Publishers–1998 (4th edition)
4. Gerhard Gottschalk–Bacterial Metabolism, Springer Verlag–1986 (2nd Edition)

Sinnott., R.K., Coulson and Richardson- Chemical Engineering Design - Butterworth-Heinemann Ltd., UK - 2003 (5th Edition)

217BIT2105	MOLECULAR PATHOGENESIS	L	T	P	C
		3	0	0	3

Course objective(s):

To gain knowledge on mechanisms of microbial pathogenesis, host defense systems, methods to study host pathogen interactions and strategies for diagnosis and control of pathogens

Course Outcomes:

At the end of the course, students would be able to

CO1: Understand the history of microbial pathogenesis.

CO2: Describe the mechanisms of host- pathogen interactions

CO3: Explain the mechanisms of host defense systems

CO4: Describe the methods used for studying host pathogen interactions.

CO5: Illustrate the classical and new therapeutic strategies for diagnosing and controlling microbial pathogens.

Mapping of Course Outcomes:

CO / PO/ PSO	PO												PSO		
	1	2	3	4	5	6	7	8	9	10	11	12	1	2	3
CO1	H			M			H								
CO2	M	M		M			H						M	H	
CO3		M					H							M	
CO4	M	M					H								
CO5		M					H							M	

Unit 1: Introduction **9 hours**

Introduction to pathogenesis, - epidemiology - various types of pathogens and modes of entry attributes and components of pathogenicity. Historical perspective – Contributions of Leewenhook, Koch, Lister and Pasteur; Koch's postulates, early discoveries of microbial toxins and antibiotics

Unit 2: Host-Pathogen Interaction **9 hours**

Virulence and virulence factors, bacterial colonization and factors involved in colonization - diphtheria toxin, exotoxin A, proteases, hemolysins, enterotoxins - virulence genes and regulation of the virulence genes - Case studies: diphtheria disease by colonisation; disease without colonization: *Clostridium botulinum* and *Staphylococcus aureus*; Intestinal infections: *Shigella* and *E. coli* infections; *Vibrio cholera Salmonella* infections; fungal infections

Unit 3: Host-Defense Mechanisms **9 hours**

Host defense against pathogens, clinical importance of understanding host defense, components of the host surface defense systems like skin, mucosa, eye, mouth, respiratory tract, physical movements, limitation of free iron, antimicrobial compounds - mechanism of

killing by humoral and cellular defense mechanisms, complements, inflammation process, general disease symptoms, Pathogenic adaptations to overcome the above defenses.

Unit 4: Experimental Methods to Study Host Pathogen Interactions 9 hours

Experimental methods to study host-pathogen interaction, selecting the pathogen model, virulence assays: cytopathic, cytotoxic effects identification of potential virulence factors; molecular characterization of virulence factors.

Unit 5: Diagnosis and Control of Pathogens 9 hours

Classical approaches based on serotyping; modern diagnosis –Immunosensors & DNA-based techniques - New therapeutic strategies – Recombinant Peptides- vaccines - DNA, subunit and cocktail vaccines.

Textbooks

1. Groisman, E.A. - Principles of Bacterial Pathogenesis - Academic Press - 2001 (1st Edition)
2. Janeway C.A. Jr, and Travers P. T. – Immunobiology- Blackwell J Scientific Publishers- 2001 (5th Edition)

References

1. Iglewski B.H. and Clark V.L. - Molecular basis of Bacterial pathogenesis- Academic press.Inc- 2012
2. Williams, P., Ketley, J. and Salmond, G. - Methods in Microbiology: Bacterial Pathogenesis - Academic Press, 1998.
3. Salyers, A.A. and Whitt, D.D. - Bacterial Pathogenesis – A molecular Approach, ASM Press, Washington - 2002 (2nd Edition)

217BIT2106	CANCER BIOLOGY	L	T	P	C
		3	0	0	3

Course Objective(s):

To understand the disarray of molecular events leading to the development of cancer and give a comprehensive view in diagnosis and treatment strategies of cancer.

CO1: Understand the fundamental processes that lead to the conversion of a normal cell into a cancer cell.

CO2: Recognize the impairment in the balance of oncogenes and tumor suppressor genes during the transformation of cancer cells.

CO3: Describe the migration of cancer cells from the primary tumor site to distant location and the processes associated with migration and establishment of secondary cancer.

CO4: Discuss the mechanism of the involvement of immune system in the cancer development.

CO5: Understand various methods of cancer diagnosis and various cancer therapeutic strategies.

Mapping of Course Outcome(s):

CO / PO/ PSO	PO												PSO		
	1	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**	**12**	**1**	**2**	**3**
CO1	H	M				M	M						M		
CO2	H	M				M									
CO3	H	M				M									
CO4	H	M				M								M	
CO5	H	M	L	L		M								H	

Unit 1: Origin of cancer **9 hours**

Tumors and monoclonal growth; Carcinogens – Physical and chemical carcinogens; Regulation of cell cycle; Growth factors – Altered signalling in growth factors and their receptors; Phosphorylation in cancer development; Ras signalling; JAK-STAT signalling; Cancer development and cell adhesion receptors; Wnt-β catenin signalling, NfκB, Notch, Patched and TGFβ signalling and cancer. Case study about nuclear radiation induced cancer

Unit 2: Oncogenes and tumor suppressor genes **9 hours**

Discovery of oncogenes; Mechanisms of activation of proto-oncogenes; Myc oncogene and activation; Tumor suppressor genes – Discovery of tumor suppressor genes; Retinoblastoma; Loss of heterozygosity; Promoter methylation.

Unit 3: Metastasis **9 hours**

Primary tumors; Invasion-metastasis cascade; Epithelial to mesenchymal transition; Factors regulating EMT; Role of E-cadherin in EMT; Cellular motility; Factors regulating cell shape, adhesion and motility; Lymphatic system and metastasis; Role of extracellular proteases in metastasis; Metastasis suppressor genes..

Unit 4: Tumor immunology **9 hours**

Immune tolerance in cancer; Immunosurveilance theory and its set back; Mechanisms of cancer cells evasion from immune system – NK-cells; Cancer cells attacking immue cells; Passive immunization with Herceptin, antibody, transfer of immune cells, Enhancing immune system to attack cancers. Case study regarding recent developments in immunotherapy for cancer.

Unit 5: Diagnosis and treatment of cancer **9 hours**

Cancer screening and early detection, detection using biochemical assays, tumor markers - Molecular tools for early diagnosis of cancer-Different forms of therapy - Chemotherapy, radiation therapy, detection of cancers, prediction of aggressiveness of cancer, advances in cancer detection, use of signal targets towards therapy of cancer - Gene therapy. Case study on novel therapeutic strategies using non-conventional cancer therepies.

Text Book:

1. Robert A. Weinberg., The Biology of Cancer, Garland Science Taylor and Francis Group, New York. 2nd Edition, 2013
2. Francesco Pezzella, Mahvash Tavassoli, and David J. Kerr., Oxford Text Book of Cancer Biology, Oxford University Press, 1st Edition, 2019.

Reference(s):

1. Vincent T. DeVita Jr, Theodore S. Lawrence, Steven A. Rosenberg. Ronald A. DePinho, Robert A. Weinberg., DeVita, Hellman, and Rosenberg's Cancer: Principles and Practice of Oncology, Wolters Kluwer / Lippincott Williams & Wilkins Philadelphia, PA. 11th edition, 2018.

217BIT2107	PLANT BIOINFORMATICS	L	T	P	C
		3	0	0	3

Course Objective(s): Students will learn databases and different tools specific for plants and be able to apply them to study gene expression analysis, plant molecular markers and plant metabolic engineering.

Course Outcomes:

After completing this course, the student will be able to:

CO1: Understand the plant database system and its significance

CO2: Analyse plant genes using software

CO3: Use tools to study plant gene expressions and RNA sequencing data analysis

CO4: Predict protein structure, evolutionary relationship and molecular marker

CO5: Apply tools related to plant metabolic engineering

Mapping of Course Outcome(s):

CO / PO/ PSO	PO												PSO		
	1	2	3	4	5	6	7	8	9	10	11	12	1	2	3
CO1	M				H							M	H		
CO2	M				H							M	H		
CO3	M	H	M	M	H							H	H		
CO4	M	H	M	M	H							H	H		
CO5	M	H	H	M	H							H	H		

Unit 1: Plant databases and information resource **9 Hours**

Collection of plant specific genomic data: NCBI, GenBank, Plant Database Resources: TIGR, MIPS and TAIR. Sol Genomics Network: *Solanaceae* plants database, MaizeGDB: Maize genome database. Plant protein database: SWISS-PROT, EXPASY.

Unit 2: Plant gene structure information resource **9 Hours**

Gene Structure Annotation at PlantGDB, GenSeqer, Gene ontology annotation, PIECE: a database for plant gene structure comparison and evolution, BAR: Bio Analytic Resource for Plant Biology

Unit 3: Plant Expression Analysis and RNA sequencing **9 Hours**

HarvEST: An EST Database and Viewing Software, BarleyBase/PLEXdb: database for plant expression and plant pathogen, RNA sequencing data analysis tools: Quality control analysis; Trimming; Reference-based genome assembly and gene ontology.

Unit 4: Tools for Phylogeny, Structure and markers **9 Hours**

Multiple Sequence Alignments: ClustalW, EMBL-EBI. Phylogenetic Analysis: MEGA, Phylogeny.fr. Heuristic Algorithms: BLAST, FASTA. Protein structure prediction and molecular visualization: PHYRE2, Swiss Model. Gene structure prediction: GENSCAN, GENEMARK, Plant Molecular marker tools: Genotyping by Sequencing: GBS

Unit 5: Tools for Plant Metabolic Engineering **9 Hours**

KEGG: Kyoto Encyclopedia of Genes and Genomes, PMN: Plant Metabolic Network, PMDB: Plant Metabolome Data Base. Metabolic engineering tool: CRISPR/CAS9 tool

Text Book:

1. Edward, D - Plant Bioinformatics: Methods and protocols - Humana Press Inc - New Jersey- 2016 (2nd edition)

Reference:

1. Aalt D.J. van Dijk – Plant Genomics Databases: Methods and protocols – Humana Press Inc – Netherlands – 2017

217BIT3108	FUNCTIONAL GENOMICS	L	T	P	C
		3	0	0	3

Course objective:

Students can enumerate the principles of functional genomics and apply at DNA, RNA and Protein level studies.

Course Outcomes:

After completing this course, the student will be able to:

CO1: Explain and analysis the DNA, RNA and Protein sequences

CO2: Understand the Genome wide analysis of DNA and RNA approaches

CO3: Enumerate the approaches of Genome wide analysis of protein

CO4: Elaborate the Whole genome analysis of prokaryote and eukaryote

CO5: Perform the Bioinformatics methods of Functional Genomics

Mapping of Course Outcomes:

CO / PO/ PSO	PO												PSO		
	1	2	3	4	5	6	7	8	9	10	11	12	1	2	3
CO1	H	H		M	M								M		
CO2	M	H		H	M								M		
CO3	H	H		M	H								M		
CO4	M	M		M	H								M		
CO5	H	M		M	M								M		

Unit 1: Analyzing DNA, RNA, and Protein Sequences 9 hours

Functional Genomics -Introduction; Access to Sequence Data and Related Information; Pairwise Sequence Alignment; Basic Local Alignment Search Tool (BLAST); Advanced Database Searching; Multiple Sequence Alignment; Molecular Phylogeny and Evolution

Unit 2:Genome wide Analysis of DNA and RNA 9 hours

DNA: The Eukaryotic Chromosome; Analysis of Next-Generation Sequence Data; Bioinformatics Approaches to Ribonucleic Acid (RNA); Genetic Interaction Mapping; DNA/Protein Interactions; DNA Accessibility Assays; Microarrays; SAGE; RNA sequencing.

Unit 3:Genome wide Analysis of Protein 9 hours

Gene Expression: Microarray and RNA-seq Data Analysis; Protein Analysis and Proteomics; Yeast two hybrid systems; MS; Protein Structure.

Unit 4: Genome Analysis 9 hours

Genomes across the Tree of Life, Completed Genomes: Viruses, Completed Genomes: Bacteria and Archaea; Eukaryotic Genomes: Fungi, Eukaryotic Genomes: From Parasites to Primates, Human Genome, Human Disease; CRISPR; RNAi

Unit 5:Bioinformatics methods of Functional Genomics 9 hours

Data clustering, Artificial neural networks; Gene Ontology – DAVID, GSEA; Deep mutational scanning; Deep mutational structure; Projects – ENCODE, GTEx.

Text Book:

1. Pevsner, Jonathan. Bioinformatics and functional genomics. John Wiley & Sons, 2015.
2. Akalin, A. (2020). Computational Genomics with R. United States: CRC Press.
3. Leister, D. (2005). Plant Functional Genomics. India: Taylor & Francis.
4. Dash, H. R. (2018). Microbial Diversity in the Genomic Era. United Kingdom: Elsevier Science.

Reference(s):

1. Lerner, K. L., Lerner, B. W. (2002). World of Genetics: A-L. United States: Gale Group.

217BIT3109	RECOMBINANT PROTEIN PRODUCTION	L	T	P	C
		3	0	0	3

Course objective:
Students can elaborate the principles and applications of recombinant protein production

Course Outcomes:
At the end of the course, students would be able to
CO1: Enumerate the recombinant protein production in bacteria
CO2: Perform the recombinant protein production using yeast and fungi
CO3: Explain the mammalian and insect as recombinant protein production factory
CO4: Elaborate the plants as recombinant protein production system
CO5: Understand the applications of recombinant protein

Mapping of Course Outcomes:

CO / PO/ PSO	PO												PSO		
	1	2	3	4	5	6	7	8	9	10	11	12	1	2	3
CO1	H	M	H	H	H								M	M	
CO2	M	H	M	H	H								M	M	
CO3	M	M	H	M	M								M	M	
CO4	H	H	H	H	M								M	M	
CO5	M	M	H	M	H								M	M	

Unit 1: Recombinant protein production in bacteria 9 hours
Bacterial expression systems - Introduction; *Escherichia coli*, *Pseudomonas fluorescens*, *Staphylococcus carnosus;* Cloning, expression, purification and characterization of recombinant protein using bacterial expression systems

Unit 2: Recombinant protein production using yeast and fungi 9 hours
Yeast expression systems - Introduction; *Arxula adeninivorans*, *Hansenula polymorpha*, *Pichia pastoris*, *Yarrowia lipolytica*, *Aspergillus sojae*, *Sordaria macrospora;* Cloning, expression, purification and characterization of recombinant protein using yeast and fungal expression systems.

Unit 3:Mammalian and Insect cells as recombinant protein production factory 9 hours
Mammalian cell lines- Introduction; HEK293 and CHO; Insect cells- Fruit flies, Mosquitos, Silkworms

Unit 4: Plants as recombinant protein production system 9 hours
Plant as recombinant protein production system- Introduction; Tobacco, Carrot, Corn, Soybean, Safflower, Rice, Tobacco, and Lettuce

Unit 5: Applications of recombinant protein **9 hours**

Recombinant hormones, interferons, interleukins, growth factors, tumor necrosis factors, blood clotting factors, thrombolytic drugs, and enzymes

Text Book:

1. Gellissen, G. (Ed.). (2006). Production of recombinant proteins: Novel microbial and eukaryotic expression systems. John Wiley & Sons.
2. Gasser, B., & Mattanovich, D. (Eds.). (2019). Recombinant Protein Production in Yeast. Humana Press.
3. Bill, R. M. (Ed.). (2012). Recombinant protein production in yeast: methods and protocols. Humana Press.

References:

1. Grandi, G. (Ed.). (2004). Genomics, proteomics and vaccines (pp. XI-XVII). Chichester: Wiley.

217BIT3110	RNAi TECHNOLOGY	L	T	P	C
		3	0	0	3

Course objective(s):

Students will be able to understand the discoveries made in gene silencing technology; their molecular mechanism and how it could be applied in agriculture and health sciences by different techniques

Course Outcomes:

After completing this course, the student will be able to:

CO1: Understanding the discovery of gene silencing phenomenon and the award of Nobel prize

CO2: Analyze the difference in methylation of DNA between transcriptional and post-transcriptional gene silencing

CO3: Understanding the synthesis of micro RNA and its biological significance

CO4: Designing of vectors and evaluating the techniques involved in RNAi technology

CO5: Apply the RNAi technology in crop improvement and controlling human diseases

Mapping of Course Outcomes:

CO / PO/ PSO	PO												PSO		
	1	2	3	4	5	6	7	8	9	10	11	12	1	2	3
CO1	H	M	M	M	M							M	L		
CO2	H	M	M	M									L		
CO3	H	M	M	H	H							M	L		
CO4	H	H	H	H	H			M				M	L		
CO5	H	H	H	H	H	H		M				H	L	M	

Unit 1: Discovery of RNA interference **9 Hours**

Introduction to Gene silencing – Different names of gene silencing, Antisense RNA technology -Discovery of gene silencing in petunia plants – Sense co-suppression in plants and animals- Discovery in nematodes (*C. elegans*) and award of Nobel Prize - Biochemistry of RNAi, Genome-wide RNAi screens in *C. elegans.* Case study on knockout/knock down strategies before the discovery of RNAi

Unit 2: **Transcriptional and Post Transcriptional gene silencing** **9 Hours**

Plasticit Methylation of DNA and proteins, Viroid infection in plants and methylation of DNA, Epigenetics, RNA directed DNA methylation (RdDM) - Proposed model of RdDM – Transcriptional gene silencing and methylation, Induction of transcriptional gene silencing, systemic silencing in plants and animals. Case study: RNAi for metabolic engineering.

Unit 3: Micro RNA **9 Hours**

Biosynthesis of micro RNA, Differences between siRNA and miRNA, - Molecular mechanism of micro-RNA mediated interference, Artificial micro-RNA, Micro RNA in plants and animals. Case study on RNA interference based therapeutics for liver fibrosis.

Unit 4: Techniques in RNAi Technology **9 Hours**

Particle bombardment method - Stable transformation of plants and animals by RNAi vectors, agroinfiltration, VIGS methodology in plants and animals, selection of siRNA sequence, delivery of siRNA using nanoparticles, transfection of siRNA Duplexes -Protein knock down detection by western blotting, RNAi microarray. Case study on REDD1 knock down for ameliorating cardiac hypertrophy by enhancing autophagy.

Unit 5: Applications of RNAi Technology **9 Hours**

RNAi for crop improvement – Functional genomics in plants by gene silencing – RNAi to control plant viruses – Viral encoded silencing suppressors and its applications –RNAi to control cancer – miRNA directed control of cancer. Case study on nanoparticle mediated RNAi for cancer treatment

Text Books:

1. Gaur R.K., Gafni Y, Sharma P, Gupta V.K - RNAi Technology - CRC Press, New York - 2011.
2. Gregory, J., Hannon - RNAi- A Guide to Gene Silencing - Cold spring harbor Laboratory Press New York - 2003.
3. Ibrokhim Y. Abdurakhmonov – RNA interference – ExLi4EvA Publications - 2016

References:

1. Ute Schepers- RNA Interference in Practice: Principles, Basics, and Methods for Gene silencing in *C. elegans,* Drosophila, and Mammals - WILEY-VCH Verlag GmbH & Co. KGaA - Weinheim – 2005
2. Kirankumar S. Mysore and Muthappa Senthil Kumar – Plant Gene Silencing Methods and Protocols – Humana Press USA - 2015

217BIT3111	VACCINOLOGY	L	T	P	C
		3	0	0	3

Course objective(s):

To relish the historical background of vaccines, its types, vaccine development and ethical issues related to use of vaccines

Course Outcomes:

At the end of the course, students would be able to

CO1: Explain the history and background of most important vaccines

CO2: Distinguish various types of vaccines and guidelines for current vaccine practices

CO3: Describe the role of adjuvants in vaccination

CO4: Assess the advantages and disadvantages of current vaccines critically

CO5: Articulate the new technologies in the development of vaccines

Mapping of Course Outcomes:

CO / PO/ PSO	PO												PSO		
	1	2	3	4	5	6	7	8	9	10	11	12	1	2	3
CO1	H		M			M	M				H	M			
CO2	H	M	H	M		H	H	H				M		H	
CO3		H	M	H		H	H	H			M	M			
CO4					H		M	M				M			
CO5	M	H	H	H		H		H				M		H	

Unit 1: Introduction to Vaccinology **9 hours**

Historical background of vaccination – vaccine preventable diseases - eradication of small pox and polio; WHO approved vaccine - human-vaccine manufacturers and licenced vaccines; immune memory of vaccines; vaccines for pregnant women and neonates; adjuvants; Correlates of protection; Delivery of vaccines, Case Studies.

Unit 2: Immune Response **9 hours**

Overview of the immune system and basic aspects of immune response(s) to vaccines. Bacterial and viral vaccines and their importance to public health: Epidemiology and pathophysiology of vaccine preventable diseases with special emphasis on Diphtheria, Tetanus and Pertussis. Appropriate and inappropriate immune response during infection: memory T and B cells Generation and Maintenance of memory T and B cells.

Unit 3: Vaccination **9 hours**

Adjuvants in Vaccination: history, types, mechanisms and current achievements, Induction of Th1 and Th2 responses by using appropriate adjuvants; Microbial, Liposomal and Micro particles as adjuvant; Dendritic cells in vaccination; Chemokines and cytokines; Role of soluble mediators in vaccination; oral immunization and mucosal Immunity

Unit 4: Vaccines **9 hours**

Conventional vaccines; Bacterial vaccines; live attenuated and inactivated vaccine; Subunit Vaccines and Toxoids; Peptide Vaccines – Examples with case studies. Vaccines for specific targets; Tuberculosis Vaccine; Malaria Vaccine; HIV vaccine and SARS-CoV-2. Vaccines for the elderly

Unit 5: New Vaccine Technologies and Future Challenges **9 hours**

Rationally designed Vaccines; Innovation in future vaccines: DNA and RNA vaccines; Mucosal vaccination; new approaches for vaccine delivery; Engineering virus vectors for vaccination. Vaccine economics, Globalization of vaccine production, Vaccine implementation on the field, Vaccine perception

Text Books

1. Stefan H.E. Kaufmann - Novel Vaccination Strategies- Wiley-VCH Verlag GmbH & Co. KgaA- 2004.

References

1. Topley & Wilson's - Microbiology and Microbial Infections Immunology - Edited by Stefan H.E. Kaufmann and Michael W Steward Holder Arnold- ASM Press- 2005.
2. Charles A Janeway. Jr, Paul Travers, Mark Walport and Mark J Shlomchik - Immuno Biology, The Immune system in health and Disease - Garland Science- New York, 2005 (6^{th} Edition)

217BIT3112	BIOPROCESS INSTRUMENTATION AND CONTROL	L	T	P	C
		3	0	0	3

Course objective(s):

To have an improved understanding of instrumentation in bioprocess and basic knowledge on control concepts

Course Outcomes:

At the end of the course, students would be able to

CO1: Classify instruments for the measurement of pressure, temperature, fluid flow and liquid level.

CO2: Understand the dynamic behavior of process systems

CO3: Develop the ability to describe quantitatively the behavior of simple control systems

CO4: To tune a control loop and to apply this knowledge in measurements

CO5: Develop the ability to design advanced control systems

Mapping of Course Outcomes:

CO / PO/ PSO	PO												PSO		
	1	2	3	4	5	6	7	8	9	10	11	12	1	2	3
CO1	H				M								H	H	
CO2	H	M		H	M								M	M	
CO3	H			H	M								M	M	
CO4	H	M		H	M	M							M	M	M
CO5	H			H	M	M							M	M	

Unit 1: Process Instrumentation **9 hours**

Principles of measurements and classification of process control instruments- Bioreactor Instrumentation- Online and offline monitoring of bioprocess- physical, chemical and biochemical parameters- Measurements of temperature, pressure, fluid flow, liquid weight and weight flow rate, viscosity, pH, concentration and composition of biomass and other metabolites- Sensors - Control of pH- dissolved oxygen- dissolved carbon dioxide- temperature of fermenters- foam-Rheological measurement and control

Unit 2: Closed Loop Control Systems **9 hours**

Development of Block diagram- Controllers and Final Control Elements- positioners- valve body, valve plugs- Valve characteristics-Transfer functions for controllers - Feedback control system-Proportional, Derivative, Integral control- Proportional- Integral (PI) - Proportional-Derivative (PD) - Proportional Integral Derivative controller (PID)

Unit 3: Open Loop Systems **9 hours**

Laplace transformation, application to solve ODEs- Open-loop systems, first order systems and their transient response for standard input functions, first order systems in series- linearization and its application in process control-second order systems and their dynamics- transportation lag.

Unit 4: Computer Control of Biochemical processes **9 hours**

Application of microcomputers in the study of microbial process- Elements of Digital computers- Computer Interfaces and peripheral devices- Fermentation software systems

Unit 5: Advanced Control Systems **9 hours**

Controller tuning- Cascade control- Feed forward and ratio control - Dead time compensation - Internal Model Control - Smith predictor controller- Programmed batch bio-reaction- Design and operation strategies for batch plants-Continuous process control.

Text Books

1. Bailey, J.E. and Ollis, D.F. - Biochemical Engineering Fundamentals- McGraw Hill Publishers, New Delhi - 2004 (2nd Edition)
2. Seborg, D. E. and Mellichamp, D. A. - Process Dynamics and Control - Wiley, New York – 2010 (3rd Edition)
3. Coughnowr, D. P. - Process Systems Analysis and Control - McGraw Hill- New York-

1991 (2nd Edition)

References

1. Harriot, P. - Process Control- Tata McGraw Hill- New Delhi- 2005 (4th Edition)
2. Smith, C. A. and Corripio, A. B. - Principles and Practice of Automatic Process Control- Wiley, New York - 1997 (2nd Edition)

217BIT3113	TRANSPORT PHENOMENA IN BIOLOGICAL SYSTEMS	L	T	P	C
		3	0	0	3

Course objective(s):

To enhance the knowledge on mass transfer concepts in biological systems

Course Outcomes:

At the end of the course, students would be able to

CO1: Describe quantitatively the properties of fluids for momentum transport

CO2: Describe the dynamics of momentum transport

CO3: Develop the ability to describe quantitatively the behavior of energy transport

CO4: Develop the ability to describe quantitatively the behavior of mass transport

CO5: Develop the ability to describe quantitatively the behavior of oxygen transport in biochemical systems

Mapping of Course Outcomes:

CO / PO/ PSO	PO												PSO		
	1	2	3	4	5	6	7	8	9	10	11	12	1	2	3
CO1	H			M									H	H	
CO2	H			M									M	M	
CO3	H			M									M	M	
CO4	H			M									M	M	M
CO5	H			M									M	M	

Unit 1: Introduction to Transport Processes in Biological Systems 9 hours

Role of transport processes in biological systems – definition of transport processes – Relative importance of convection and diffusion – Transport within cells – Trans cellular transport – Physiological transport systems – Application of transport processes in disease pathology, treatment and device development – Relative importance of transport and reaction processes

Unit 2: Momentum Transport in Biological Systems 9 hours

Rheology and flow of blood – Conservation of mass in 3-D – Conservation of linear momentum and Navier-Stokes equation – Fluid motion with more than one independent variable – Dimensional analysis and Dimensionless groups

Unit 3: Physiological Flow in Biological Systems **9 hours**

Integral form of equation – Bernoulis equation applied to Stenotic heart valves – Boundary layer theory – Flow separation – Lubrication theory – peristaltic pumping

Unit 4: Mass Transport in Biological Systems **9 hours**

Solute fluxes in mixtures – Conservation relations – Constitutive relations – Diffusion as random walk – Estimation of diffusion coefficients in solution – Steady state diffusion in one dimension– unsteady state diffusion in one dimension – Diffusion limited reactions – Electrolyte transport – Diffusion and convection

Unit 5: Porous Media and Trans vascular Transport **9 hours**

Porosity, tortuosity and volume fraction – Fluid flow in porous media – Solute transport in porous media – Fluid transport in poroelastic materials – Pathways for transendothelial transport – rates of transvascular transport – Phenomenological constants in the analysis of transvascular transport - Limitation of Starlings law

Text Book

1. Truskey, G.A., Yuan, F., David, F.K. - Transport Phenomena in Biological Systems- Prentice Hall, New Jersey – 2009 (2nd Edition)

Reference

1. Bird, R.B., Stewart, W.E., Lightfoot, E.N. - Transport Phenomena, Revised - John Wiley and Sons- Singapore – 2007 (2nd Edition)

217BIT3114	SIGNAL TRANSDUCTION	L	T	P	C
		3	0	0	3

Course Objective(s):

To describe messengers in various signals, structure and mechanism of receptors, how to communicate signalling through phosphorylation and how they are interact plant microbe interactions

Course Outcomes:

At the end of the course, students would be able to

CO1: List the key signaling in biology and how to regulate cells and cell cycles

CO2: Demonstrate structure, function and modulation of different receptors and its cross talk with in the cell communication

CO3: Explain and illustrate how cells are communicating neighbor cells through protein signaling

CO4: Discuss molecular mechanism of signals in microbes and plants through regulation of defense and elicitors and root nodule in rhizobium

CO5: Explain importance and various classifications of signal proteins and its functional alteration of cells

Mapping of Course Outcomes:

CO / PO/ PSO	PO												PSO		
	1	2	3	4	5	6	7	8	9	10	11	12	1	2	3
CO1	H			H		H				H			L		
CO2	H			M		M		M				M	L		
CO3	H		H		M		M	H	M		M		L		
CO4	H	H		M	H	M					M	M	L		
CO5	H					M		M		M		M	L		

Unit 1: SIGNALS IN BIOLOGY **9 hours**

Introduction - basic elements of cell signaling systems - sensors, autocrine, paracrine and endocrine signaling molecules, first messengers, secondary signaling molecules, G-protein, coupled signal transduction pathway involving cAMP, cGMP, IP3, DAG and Ca^{2+} as second messengers, calcium signaling, regulation of the cell cycle by protein kinases pathway, programmed cell death pathway.

Unit 2: STRUCTURE AND FUNCTION OF SIGNALING PATHWAY **9 hours**

Ligand and receptors structure, types and functions, adapter molecules, signaling cascade, transcription factors and its regulation, gene activation- signal switches Wnt signaling, Notch signalling and Hedghock signaling- MAP Kinase Pathways, TGF- growth factor receptor, insulin receptor, GPCR regulate cyclic nucleotide gated ion channels,- cross-talk among different signaling, pathways, the role of NO as an intercellular messenger

Unit 3: CELLS IN THEIR SOCIAL CONTEXT **9 hours**

Cell junctions: occluding, adherent, gap junctions connexins proteins – cell – cell adhesions, cadherins, integrins, and selectins, adhesion receptors – extracellular matrix proteins and its types, matrix influenced cell shape and cell migration – plant cell wall and its contact, adhesive molecules in plant

Unit 4: SIGNALING IN MICROORGANISMS AND PLANTS **9 hours**

Phenyl propanoid metabolic pathway overview- phytohormones and its types - auxin, cytokinins, vegetative development, abscisic acid, giberlic acid regulated growth repressor, strigolactones, gibberellins & brassinosteroids, ethylene, jasmonates & salicylates, super oxide anion, - pathogenesis related proteins, elucitors and its mechanism - signaling in transport and the control of plant growth and development, the roll of signaling in formation of root nodule in rhizobium.

Unit 5: SIGNAL TRANSMISSION VIA PROTEINS **9 hours**

General classification of proteins, membrane and cytoplasmic proteins- mechanism of phosphorylation, phosphorylation of activation and inactivation, acetylation, palmitoylation, sumolation, mrystioylation, src homolog function as tyrosin kinase, structure and function of SH2 domain, ERK pathway, Jak-STAT pathway, MAPK pathway, case study gene mutation leads to development of diseases like cancer etc.

TEXT BOOKS

1. B. D. Gomperts, Peter E. R. Tatham, Ijsbrand M. Kramer, Signal transduction, Academic Press, 2nd Edition, 2009.
2. Bruce Alberts, Alexander Johnson, Julian Lewis, Martin Raff, Keith Roberts, and Peter Walter., Molecular Biology of the Cell, Garland Science;. New York, 6th Edition, 2014.

217BIT3115	STRUCTURAL BIOLOGY	L	T	P	C
		3	0	0	3

Course objective(s):

To describe the various structural forms of proteins; To understand the protein expression technologies; To enumerate the process of crystallization and crystal engineering; To describe the purification and crystallization of membrane proteins and understand the basics of interaction analysis.

Course Outcomes:

After completing this course, the student will be able to:

CO1: Describe the various structural forms of proteins

CO2: Understand the protein expression technologies

CO3: Enumerate the process of crystallization and crystal engineering

CO4: Describe the purification and crystallization of membrane proteins

CO5: Understand the basics of interaction analysis

Mapping of Course Outcomes:

CO / PO/ PSO	PO												PSO		
	1	2	3	4	5	6	7	8	9	10	11	12	1	2	3
CO1	H			H									H	H	
CO2	H			H									H	H	
CO3	H			H									H	H	
CO4	H			H									H	H	
CO5	H			H									H	H	

Unit 1: Introduction to Protein Structure **9 hours**

Structure of proteins: Primary, Secondary, Tertiary and Quaternary structure of proteins; Super-secondary structure of proteins; Domains, motifs, and folds in protein structure - Structural domain, Structural and sequence motif, Protein folding; Protein structure determination; Protein structure classification.

Unit 2: Expression of Proteins **9 hours**

Expression in bacteria (*Escherichia coli*), insect (*Sf*9 and *Sf*21), mammalian Cells (HEK293 and CHO), Yeast (*Saccharomyces cerevisiae*); prominent expression systems: MultiBac System; Purification using His-Tag technology; Cell-free protein production.

Unit 3: Protein Crystallization and Crystal Engineering 9 hours

Selection of cryoprotectants and multistep soaking system; Protein modification for crystallization; Characteristics of macromolecules in the crystalline state; Hydrogen and water molecules in crystalline proteins; X-ray diffraction and Bragg equation; Metal ions and proteins interactions; Protein and lipid interactions.

Unit 4: Purification and Crystallization of Membrane Proteins 9 hours

Membrane protein purification and crystallization- Chromatographic Techniques and Basic Operations in Membrane Protein Purification- Production and purification of recombinant membrane proteins - SDS Electrophoresis Techniques - Blue-Native Electrophoresis- Preparative Isoelectric Focussing-Introduction to PDB Data**.**

Unit 5: Interaction Analysis 9 hours

Analytical ultracentrifugation; Mass spectrometry; Nuclear Magnetic Resonance (NMR) and Cryo-Electron microscopy, advantages and disadvantages of all the processes

Text Book:

1. T. Senda, M. Katsumi - Advanced Methods in Structural Biology- Springer protocols handbooks- 2016 (1st Edition)- ISBN 9784431560289.

Reference(s):

1**.** L.J. Banaszak - Foundations of structural biology- Academic Press- 2000 (1st Edition) - ISBN 978-0-12-077700-6.

2**.** L. Anders, L. Liljas, J. Piškur, G. Lindblom, P. Nissen, M. Kjeldgaard - Textbook of structural biology- Singapore: World Scientific - 2009 (1st Edition)- ISBN 978-981-277-207-7

217BIT3116	SYSTEMS BIOLOGY	L	T	P	C
		3	0	0	3

Course Objective(s):

To describe overview, structural, biochemical, molecular, proteomics analysis of network constructions and their applications

Course Outcomes:

At the end of the course, students would be able to

CO1: List the overview and fundamentals of systems biology

CO2: Demonstrate the structural modeling and biochemical analysis of network interactions

CO3: Explain the systems biological applications of developmental biology

CO4: Discuss the construction of network through gene expression

CO5: Explain importance and various techniques involved to construction of network

Mapping of Course Outcomes:

CO / PO/ PSO	PO												PSO		
	1	2	3	4	5	6	7	8	9	10	11	12	1	2	3
CO1		M	M	M	H	M		M		M			H		
CO2	H	M		M	M	M		M		M	M	M	H		
CO3	H	M		H				H		M	M	M	H		
CO4	H	M			M				M		M		H		
CO5	H	M	M	M			M	H		M	M	H	H		

Unit 1: SYSTEMS BIOLOGY – FUNDAMENTALS 9 hours

Overview of Gene Control –Working of Genetic Switches – Introductory Systems Biology: The biochemical paradigm, genetic paradigm and the systems paradigm. Basic notion for computational model, network, data interactions,- network motifs, genetic network evolution, and cellular decision-making.

Unit 2: STRUCTURAL MODELLING AND ANALYSIS OF NETWORK 9 hours

Overview of common modeling approaches for biochemical network- structural analysis of biochemical network – flux cone – elementary flux model and extreme pathway- kinetic models of biochemical network- data resources for modeling of cellular reaction systems-

Unit 3: BUILDING SYSTEMS BIOLOGICAL NETWORK 9 hours

Building an Organism starting from a single cell -Quorum Sensing – Programmed Population Control by Cell-Cell Communication and Regulated Killing- Gene ontology database, String database, IntAct data analysis, cytoscape, BioGRID, inBio discover, Visualization of protein-protein interactome.

Unit 4: GENE EXPRESSION NETWORKS 9 hours

Gene regulation at a single cell level- Transcription Networks -basic concepts -coherent Feed Forward Loop (FFL) and delay gate -The incoherent FFL -Temporal order, Signaling networks and neuron circuits -Aspects of multi-stability in gene networks.

Unit 5: EXPERIMENTAL TECHNIQUES 9 hours

Cloning vectors and DNA libraries – 1D and 2D gel electrophoresis – protein separation techniques - Hybridization and blotting techniques – Yeast two hybrid screenings – DNA protein chips – Mass spectrometry – RNA interference

TEXT BOOKS

1. E. Klipp, Lebermeister, W. C. Wierling A. Kowald, Systems Biology, Willey-Vch, 2nd Edition, 2016.
2. Pablo A. Iglesias, Brian P. Ingalls. Control Theory and Systems Biology, MIT Press, UK, London 1st Edition, 2016.

UNIVERSITY ELECTIVES

214BIT1101	INTRODUCTION TO COMPUTATIONAL BIOLOGY	L	T	P	C
		3	0	0	3

Course Objective:
Students can elaborate the principles of Computational Biology and its applications

Course Outcomes:
At the end of the course, students would be able to
CO1: Enumerate the basics of Molecular Biology, Mathematics, Statistics and Computer Science
CO2: Explain the niche areas of Molecular Biology
CO3: Understand the basics of Bioinformatics
CO4: Elaborate the advancements made in Bioinformatics
CO5: Understand the niche areas of Mathematics, Statistics and Computer Science

Mapping of Course Outcomes:

CO/ PO	PO											
	1	2	3	4	5	6	7	8	9	10	11	12
CO1	H	H		M	M							
CO2	M	H		H	M							
CO3	H	M		H	H							
CO4	M	M		M	H							
CO5	H	M		H	M							

Unit1: Basics of Molecular Biology, Mathematics, Statistics & Computer Science 9 hours
Molecular Biology, Mathematics, Statistics, and Computer Science; Molecular Biology-DNA and Proteins, The Central Dogma, The Genetic Code Transfer, RNA and Protein Sequences, Mathematics- Introduction to Graphs, Interval Graphs; Probability and Statistics; Basics of Computer Science.

Unit 2:Niche areas of Molecular Biology 9 hours
Cloning and Clone Libraries; Random Clones; Libraries by Complete Digestion; Libraries by Partial Digestion; Physical Genome Maps: Oceans, Islands, and Anchors; Mapping by Fingerprinting; Mapping by Anchoring; An Overview of Clone Overlap; Sequence Assembly; Shotgun Sequencing; Sequencing by Hybridization.

Unit3: Basics of Bioinformatics 9 hours
Databases and Rapid Sequence Analysis; DNA and Protein Sequence Databases; Hashing a Sequence; Repeats in a Sequence; Sequence Comparison by Hashing; Sequence Comparison by Statistical Content; Dynamic Programming Alignment of Two Sequences; Global Distance Alignment; Global Similarity Alignment; Multiple Sequence Alignment, Trees and Sequences; Trees- Distance- Parsimony- Maximum Likelihood Trees

Unit4: Advanced Bioinformatics **9 hours**

Local Alignment and Clumps; Linear Space Algorithms; Tracebacks; Inversions; Map Alignment; Parametric Sequence Comparisons; Dynamic Programming in r-Dimensions; Weighted-Average Sequences; Profile Analysis; Alignment by Hidden Markov Models Consensus Word Analysis

Unit5: Niche areas of Mathematics, Statistics and Computer Science **9 hours**

Extreme Value Distributions; The Chein-Stein Method; Poisson Approximation and Long Matches; Sequence Alignment with Scores; Probability and Statistics for Sequence Patterns; A Central Limit Theorem; Non-overlapping Pattern Counts

Text Book:

1. Waterman, M. S. (2018). Introduction to Computational Biology: Maps, Sequences and Genomes. United States: CRC Press.
2. Wong, K. (2021). Computational Biology and Bioinformatics: Gene Regulation. (n.p.): Taylor & Francis Limited.
3. Schonbach, C., Nakai, K. (2018). Encyclopedia of Bioinformatics and Computational Biology: ABC of Bioinformatics. Netherlands: Elsevier Science.

References:

1. Wünschiers, R. (2015). Computational Biology: A Practical Introduction to BioData Processing and Analysis with Linux, MySQL, and R. Germany: Springer Berlin Heidelberg.

214BIT1102	EXPLORING THE MICROBIAL WORLD	L	T	P	C
		3	0	0	3

Course objective(s):

To explore the basic knowledge about microorganisms and their importance

Course Outcomes

At the end of this course, students will be able to:

1. Understand the basic history, identify and characterize the major groups of microorganisms.
2. Distinguish among prokaryotic and eukaryotic structure, organization, metabolism and environmental needs of organisms.
3. Identify and discuss the importance of microbial genetics and metabolism.
4. Express the role of microorganisms in the environment.
5. Explain the fundamental mechanisms of the human immune response and characterize the body's defenses against infectious agents.

Mapping of Course Outcomes:

	PO 1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO 10	PO 11	PO 12
CO 1	H											
CO 2	H							L				H
CO 3	H				L		H					
CO 4			L	L	H				H	L		
CO 5							L	H		L		H

Unit 1: History of Microbiology **9 hours**

Contributions of Leeuwenhoek, Pasteur, Koch, Lister, Tyndall, etc. Biogenesis vs Abiogenesis, Koch's postulates, discovery of antibiotics and Vaccine.. Classification of living organisms; Heckel, Whittaker and carlwoese systems. Place of microorganisms in the living world. Taxonomy– Principle and its types (Classical approach– Numerical, Chemical, Serological and Genetic)

Unit 2: Microbial Characteristics and Classification **9 hours**

Differentiating features, habitats, reproduction and classification of bacteria, viruses, algae and fungi, actinomycetes, yeast, mycoplasma and bacteriophages. Microbial spores and process of sporulation / germination process. Types of microbial pathogens and disease caused by them. Normal micro flora in humans / animals and host defense Microbial interactions like symbiosis and antibiosis etc.

Unit 3: Microbial Genetics and Metabolism **9 hours**

Conjugation, Transduction, Transformation, isolation of auxotrophs, replica plating techniques, analysis of mutations in biochemical pathway, one gene – one enzyme hypothesis. Unique pathways, photosynthesis, fermentation and its products, Gentic Improvement of microorganisms

Unit 4: Microbes and Environment **9 hours**

Role of microbes in environment – positive and negative roles. Biodegradation of lignin, pesticides, bioaccumulation of heavy metals and detoxification, biopesticides, genetically modified organisms – Concerns and advantages. Bioremediation of polluted water. Use of rDNA technology in microbes, Nitrogen fixing microbes in agriculture.

Unit 5: Infection and Immunity **9 hours**

Source of infection of humans, vehicles of reservoir of infection. Exogenous infection: Patients, carrier, infected animals. Endogenous infections. Mode of spread of infection – Respiratory, skin, wound and burn, venereal infection, arthropod borne infection, alimentary tract infection, laboratory infections. Microbial pathogenesis – Transmission, infection and virulence, toxigenicity and invasiveness. Host defense mechanism against pathogens.

References

1. Prescott, L.M J.P. Harley and C.A. Klein 1995. Microbiology 2nd edition Wm, C. Brown publishers.
2. Michael J. Pelczar, Jr. E.C.S. Chan, Moel : Microbiology Mc Graw Hill Book R. Krieg, 1986 Company
3. Stainer R.Y. Ingraham J.L. Wheolis H.H and Painter P.R. 1986 The Microbial world, 5th edition. Eagle Works Cliffs N.J. Prentica Hall.

214BIT1103	HUMAN DISEASES AND PREVENTION	L	T	P	C
		3	0	0	3

Course objective(s):

To get familiar with various human diseases and its preventive measures

Course Outcomes

At the end of the course, students would be able to

CO1: Understand the fundamentals of public health system.

CO2: Describe the diseases caused by microorganisms.

CO3: Explain the significance of non-communicable diseases.

CO4: Understand the basis of the diseases of genetic origin.

CO5: Describe the principles of disease prevention.

Mapping of Course Outcomes:

CO / PO	PO											
	1	2	3	4	5	6	7	8	9	10	11	12
CO1	M								M			
CO2	M		H						M			
CO3	M								M			
CO4	M								M			
CO5	M	M	H					H	M			

Unit 1: INTRODUCTION TO PUBLIC HEALTH **9 hours**

Fundamentals of public healthcare - Promise and practice of public health - Health impact pyramid; Origins of public health. Ecological and social determinants of health; Organization and financing of public health; Overview of healthcare law and policy.

Unit 2: COMMUNICABLE DISEASES **9 hours**

Diseases of microbial origin acquired through respiratory route - tuberculosis; Diseases of microbial origin acquired through alimentary route - cholera; Diseases of microbial origin acquired through skin, mucosa, and blood stream; Diseases of microbial origin acquired through vectors - Malaria.

Unit 3: NON-COMMUNICABLE DISEASES **9 hours**

Diabetes: Classification, disease mechanism, symptoms, epidemiology, organ systems affected; Obesity: Fundamentals of obesity, Health burden originating from obesity, Associated complications; Overview of cardiovascular disorders; Introduction to cancer

Unit 4: DISEASES OF GENETIC ORIGIN **9 hours**

Fundamentals of genetics; Brief introduction to genetic disorders - Autosomal dominant - Autosomal recessive - X-linked dominant - X-linked recessive - Y-linked disorders.

Unit 5: PREVENTION OF DISEASES **9 hours**

Antibiotics and Disinfectants in controlling diseases of microbial origin; Cancer therapeutics - Radiation therapy, Chemotherapy, Surgical therapy; Life style changes to prevent obesity, and type 2 diabetes; Molecular cytogenetics and prenatal diagnosis of genetic disorders.

Text Books

1. Ryan KJ, Ray CG - Sherries Medical Microbiology: Introduction to infectious diseases - McGraw-Hill -2003 (4th Edition).
2. Cummings MR. - Human Heredity: Principles and issues - Yolanda Cossio - 2014 (10th Edition)

Reference

1. Goldsteen RL, Goldsteen K and Dwelle T - Introduction to public health: Promise and Practice - Springer Publishing Company - 2014 (2nd Edition).

214BIT1104	ENVIRONMENTAL MICROBIOLOGY	L	T	P	Credit
		3	0	0	3

Course objective(s):

To appreciate the importance of microorganisms in context to environment

Course Outcomes:

At the end of this course, students will be able to

CO1: Recognize the importance of microbial diversity and their different environment
CO2: Describe microbial processes of environmental and geochemical significance
CO3: Provide detailed information on the most up to date methods for the study of microbial indicators
CO4: Explain the different microbiological waste treatment methods
CO5: Demonstrate the importance of microbes in various applications

Mapping of Course Outcomes:

CO/ PO	PO											
	1	2	3	4	5	6	7	8	9	10	11	12
CO1	H						H					
CO2	H	M					H					
CO3	H		M	M			H					
CO4	H	H	M				H					
CO5	H		H		M		H					

UNIT I : DIVERSITY OF MICROORGANISMS 9 hours

Introduction; history of environmental microbiology; prokaryotes versus eukaryotes-eukaryotic and prokaryotic cell structure, general characters; three domains of life; important uses and harmful effects of a) protozoa b) algae, c) fungi, d) bacteria and e) virus; effects and microbial adaptations to environmental conditions - temperature, oxygen, desiccation, extreme cold, ionic effect, osmotic pressures, radiant energy, hydrostatic pressures.

UNIT II : NUTRITION, GROWTH AND CONTROL OF MICROORGANISMS 9 hours

Nutritional requirements: macronutrients, micronutrients, trace metals and growth factors, nutrient media and growth conditions, nutritional types based on energy source; bacterial growth curve; methods for determining bacterial numbers, mass and cell constituents; inhibition of microbial growth, sterilization and disinfection, antisepsis and sanitation, mode of action: physical and chemical agents; classes of disinfectants: phenol and phenolics alcohol, halogens; factors affecting sterilization and disinfection.

UNIT III: BIOINDICATORS 9 hours

Bioindicators: definition; plankton community as indicators of water pollution; use of diversity index in evaluation of water quality; determination of microbiological quality of recreational and potable waters; indicator organisms, coliforms and *E. coli*, fecal *Streptococci*, clostridia, heterotrophic plate counts etc.; lichens as air pollution indicators.

UNIT IV: MICROBIOLOGICAL WASTE TREATMENT METHODS 9 hours

Activated sludge process; anaerobic sludge digestion; root zone technology; microbial biosorption technology; mass scale production of Effective Microorganisms (EM) for waste treatment; economics of waste treatment; bacteriology of water and sewage; bacteriological examination of water; biodegradation of plastic, pesticides and hydrocarbons; microalgal bioremediation of heavy metals.

UNIT V: MICROBIAL APPLICATIONS IN ENVIRONMENT 9 hours

Biopesticides; biofertilizers; biofuels; biosensors; bioindicators; biodegradable plastics; factors affecting the bioremediation processes; effects of co-substrates on microorganisms; phytoremediation; sequestering carbon dioxide; biomonitoring; biomembrane reactors; important case studies in environmental biotechnology: oil spill, textile wastewater treatment, chromium reduction.

TEXTBOOKS

1. Madigan M.T, Martinko J.M, Parker J-Brock biology of microorganisms-Upper Saddle River, NJ, Prentice hall–2014 (14^{th} Edition)
2. Willey J.M, Sherwood L, Woolverton C.J, Prescott L.M-Microbiology-McGraw-Hill Higher Education-New York, USA-2008 (7^{th} Edition)
3. Schlegel H.G, Zaborosch C-General microbiology-Cambridge University Press, New York, USA-1993.

REFERENCES

1. Maier R.M, Pepper I.L, Gerba C.P-Environmental Microbiology-Academic Press-2009.

2. Mohapatra P.K-Textbook of Environmental Microbiology-IK International Publishing House, New Delhi, India-2008.

214BIT1105	BIORESOURCE TECHNOLOGY	L	T	P	C
		3	0	0	3

Course Objective(s):

To develop knowledge in renewable and non-renewable energy sources and to understand the mechanisms of various bio energy production techniques

Course Outcomes:

At the end of the course, students would be able to

CO1: Identify various renewable energy sources

CO2: Describe large- scale fuel technologies and bioconversions

CO3: Demonstrate how biogas is produced from various bio-resources

CO4: Distinguish between the processes involved in bioethanol and butanol production

CO5: Evaluate the mechanisms involved in biodiesel production

Mapping of Course Outcomes:

CO / PO	PO											
	1	2	3	4	5	6	7	8	9	10	11	12
CO1	H											
CO2					M				H			
CO3		H		H			M				H	M
CO4			M			H		M		M		
CO5	M											

UNIT I :Renewable Energy Source

Hydropower, geothermal power, solar power, wind power with suitable case studies – Biofuel - Biomass - Feed stocks (agricultural crops, bioenergy crops, agricultural waste residues, wood residues, waste stream)

UNIT II :Fuel Technology and Bioconversion

History - Definition of biofuel, applications of biofuel (transport, direct electricity generation, home use and energy content of biofuel) - Bioconversion of lignocellulose, cellulose saccharification, pretreatment technologies (air separation process, mechanical size reduction, autohydrolysis) - Pulping and bleaching – Enzymatic deinking.

UNIT III :Biogas

Biogas plant, feed stock materials, biogas production, factors affecting methane formation - Role of methanogens – Biohydrogen production by algae and photosynthetic bacteria with suitable case studies

UNIT IV :Bio Ethanol and Butanol

Advantages of ethanol over fossil fuels, production of ethanol from cellulosic materials, ethanol recovery - Biobutanol production, energy content and effects on fuel economy with

suitable case studies - Octane rating, air fuel ratio, specific energy, viscosity, heat of vaporization -Butanol fuel mixtures

UNIT V: Biodiesel

Production of biodiesel, oil extraction from algae by chemical solvents, enzymatic, expeller press - Osmotic shock and ultrasonic assisted extraction - Applications of biodiesel, environmental benefits and concerns

Text Book(s):

1. Alain A.V., Biomass to biofuels strategies for global Industries, John Wiley & sons ltd, 1st Edition, 2010.
2. Twidell., J & Weir., T., Renewable energy resources, Taylor & Francis 2nd Edition, 2006.

Reference(s):

1. Luque, R., Camp, J., Hand book of biofuel production processes and technologies, Woodhead publishing ltd., 1st Edition, 2011.

214BIT1106	BIOLOGICAL WASTEWATER TREATMENT	L	T	P	C
		3	0	0	3

Course objective(s):

To understand the basics in biological methods for waste water treatment

Course Outcomes:

At the end of this course, students will be able to

CO1: Apply the fundamental physico-chemical and microbiological principles behind wastewater treatment processes

CO2: Understand the various principles that underlie major unit operations used in bioprocess treatment.

CO3: Explain the principles of activated suspended and attached sludge processes

CO4: Describe the principles and significance behind biological nutrient removal

CO5: Explain the tools and techniques involved in anaerobic treatment and sludge disposal

Mapping of Course Outcomes:

CO/ PO	PO											
	1	2	3	4	5	6	7	8	9	10	11	12
CO1	H			M			M					
CO2	H		M				M					
CO3	H		H			M						
CO4	H	M	H			M						
CO5	H	H	H			M	M					

Unit 1: Overview **9 Hours**

The main pollutants and their effects on the environment. Characteristics, type and quantity of municipal effluent. Typical loads pollution in municipal wastewater. Physical treatment process - Principles of Screening – Mixing, Equalization – Sedimentation – Filtration – Adsorption – membrane separation, Reverse Osmosis, Principles of Chemical treatment – Coagulation flocculation – Precipitation – flotation – Disinfection, advanced oxidation.

Unit 2: Principles of Bioprocess Treatment **9 Hours**

Objectives of biological treatment – significance – Biochemical environments: aerobic, anaerobic and anoxic. Microbial diversity in wastewater treatment process; Kinetics of biological growth – Factors affecting growth – attached and suspended growth – Biodegradability assessment; Concepts of Oxygen Demand – BOD and COD. Water Quality and Dissolved Oxygen.

Unit 3: Activated Sludge Processes **9 Hours**

Aerobic biological oxidation, process description, environmental factors, Oxidation Ditch systems, Principles of aeration, factors affecting oxygen transfer, Final clarification. Introduction to attached growth systems, Applications of rotating biological contactors, Bio-Towers, Process design considerations. Aerobic stabilization ponds; Maturation ponds, Constructed wetlands.

Unit 4: Biological Nutrient Removal **9 Hours**

Biological removal of nitrogen. Nitrification. Biochemistry and microbiology of the process. Denitrification. Biochemistry and microbiology of the process. Incorporation into the activated sludge. Biological phosphorus removal, Removal of phosphorus by chemical addition. Combined removal of nitrogen and phosphorus by biological methods.

Unit 5: Anaerobic and Sludge Treatment Processes **9 Hours**

Anaerobic process description. Comparison with the aerobic processes. Types of Anaerobic reactors. Production of biogas. Characteristics of the sludge. Reuse and disposal of sludge. Operations and processes for sludge treatment. Thickening. flotation. Aerobic digestion. Anaerobic digestion.

Textbook(s):

1. Metcalf and Eddy - Wastewater Engineering, Treatment and Reuse - Tata McGraw Hill - New Delhi - 2003

Reference(s):

1. Qasim, S.R., Motley, E.M. and Zhu G - Water Works Engineering – Planning, Design and Operation - Prentice Hall - New Delhi, 2002
2. Arceivala, S.J. - Wastewater treatment for pollution control – TMH - New Delhi – 2008

214BIT1107	BIO-CORROSION	L	T	P	Credit
		3	0	0	3

Course objective(s):
To provide understanding of types of corrosion with special emphasize on bio-corrosion

Course Outcomes:
At the end of this course, students will be able to
CO1: Understand the principles of corrosion
CO2: Analyze the factors influencing corrosion
CO3: Explain the methods to study corrosion
CO4: Describe the principles and significance behind chemical corrosion
CO5: Understand microbial corrosion

Mapping of Course Outcomes:

CO/ PO	PO											
	1	2	3	4	5	6	7	8	9	10	11	12
CO1	H					M	M					
CO2	H					M	M					
CO3	H					M	M					
CO4	H					M	M					
CO5	H					M	M					

Unit 1: Types of Corrosion **9 hours**
Introduction; Corrosion; Mechanism of Dry and Wet Corrosion; Dry Corrosion (Chemical Corrosion); Wet Corrosion (Electrochemical Corrosion); Electrochemical Theory of Corrosion (Mechanism of Rusting of Iron); Types of Corrosion-Galvanic Corrosion (Bimetallic Corrosion); Pitting Corrosion; Differential Aeration Corrosion (Concentration Cell Corrosion); Waterline Corrosion; Stress Corrosion (Stress Cracking); Soil Corrosion; Microbial Corrosion;

Unit 2: Factors Influencing Corrosion **9 hours**
Factors Affecting the Rate of Corrosion; Preventive Measures of Corrosion (Corrosion Control)-Using Pure Metal; Using Metal Alloys; Proper Designing; Cathodic Protection (Electrical Protection); Protective Coatings; Electroplating; Galvanization and Tinning.

Unit 3: Measurement Techniques **9 hours**
Electrochemical methods to Measure Corrosion: DC Polarization, linear polarization method, AC Impedance; Experimental measurement of corrosion Quantification of corrosion Environmentally Induced Cracking, Corrosion Fatigue, Hydrogen Induced Cracking, Application of Fracture mechanics.

Unit 4: Chemical Corrosion **9 hours**
Corrosion by water – importance of water, corrosion and water quality. Types of water – cooling water systems, steam generation systems. Water treatment, scaling indices. Ion associated models. Atmospheric Corrosion, Oxidation in Gaseous Environments, Ellingham Diagrams, Role of Protective Scale, Molten Salt Corrosion. Chemical processes industry (like

Pulp mill operations, bleach plants, boilers, paper machine, water treatment plants in the pulp and paper industry) infrastructure and transportation industry.

Unit 5: Microbial Corrosion **9 hours**

Microbiologically influenced corrosion (MIC) – Causative organisms and mechanisms, Biofilm formation and reactions. Identification of causative organisms. Measurement of MIC. Impact of engineering practices on susceptibility to MIC. Strategies to prevent MIC. Environmental degradation of ceramics, Degradation of Polymeric Materials, Failure analysis, Corrosion Prevention methods.

Text Book

1. Pierre R.Roberge: Corrosion engineering – Principles and practice. The McGraw-Hill Companies, Inc. (2008).

References

1. D. A. Jones: Principles and Prevention of Corrosion, Macmillan Publ. Co. (1996).
2. C. Scully: The Fundamental of Corrosion, 2nd ed., Pergamon Press: E. E. Stansbury and R. A. Buchanan, Fundamentals of Electrochemical Corrosion, ASM International (2000).
3. M.G. Fontana: Corrosion Engineering, 3rd. Ed., McGraw Hill. (1986).
4. J. M. West: Electro deposition and Corrosion Control, W. Revie (ed.): Corrosion Handbook, Electrochemical Society Series, John Wiley and Sons, 2000.
5. S.W.Borenstein, Microbiologically influenced corrosion handbook, Woodhead pub. Ltd., Cambridge (1994).

214BIT1108	BIOLOGY OF CANCER	L	T	P	C
		3	0	0	3

Course objective(s):

To provide an overview of structure and function of cell, importance of cell cycle in context to cancer and carcinogenesis

Course Outcomes

At the end of the course, students would be able to

CO1: Understand the fundamentals of a cells and its organization.

CO2: Describe how the cells undergo cell division and the cell cycle.

CO3: Explain the process by which a normal cell turns into a cancerous cell.

CO4: Understand the mechanisms by which chemical carcinogens and radiation causes cancer.

CO5: Describe the underlying pathways and molecular mechanisms of cancer.

Mapping of Course Outcomes:

CO / PO	PO											
	1	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**	**12**
CO1	H	H		M				H			M	
CO2	H	H		M				M				
CO3	H	M		M							M	
CO4	H	M	M	M	M		M	M				
CO5	H	H		M							M	

Unit 1: Basics of cancer

Cancer definition; Types of cancer; Terminologies in cancer – Nomenclature of cancer types; Mutations; Carcinogens – Physical, Chemical and Biological;

Unit 2: Cell Cycle and Cell Division

Cell cycle – M Phase, G1 Phase, S Phase, G2 Phase, G0 Phase; Cell cycle regulation; Dysregulation of cell cycle in cancer.

Unit 3: Fundamentals of Cancer Biology

Mutations that cause changes in signal molecules - Effects on receptor, signal switches, tumour suppressor genes - Modulation of cell cycle in cancer, different forms of cancers, diet and cancer

Unit 4: Principles of Carcinogenesis

Theory of carcinogenesis - chemical carcinogenesis, metabolism of carcinogenesis, principles of physical carcinogenesis, x-ray radiation - mechanisms of radiation carcinogenesis

Unit 5: Principles of Molecular Cell Biology of Cancer

Signal targets and cancer, activation of kinases - oncogenes, identification of oncogenes, retroviruses and oncogenes - Detection of oncogenes, oncogenes and proto oncogene activity - Growth factors related to transformation - Telomerases

Text Books

1. Robert A. Weinberg., The Biology of Cancer, Garland Science Taylor and Francis Group, New York. 2nd Edition, 2013
2. De Robertis EDP and De Robertis EMF - Cell and Molecular Biology - Lippincott Williams & Wilkins - 2010 (8th Edition).

Reference

1. Vincent T. DeVita Jr, Theodore S. Lawrence, Steven A. Rosenberg. Ronald A. DePinho, Robert A. Weinberg., DeVita, Hellman, and Rosenberg's Cancer: Principles and Practice of Oncology, Wolters Kluwer / Lippincott Williams & Wilkins Philadelphia, PA. 11th edition, 2018.

214BIT1109	ENGINEERING OF CROP PLANTS	L	T	P	Credit
		3	0	0	3

Course objective(s):

To teach them the methods of plant genetic engineering and applying them to improve the quality of food or fodder crops

Course Outcomes:

After completing this course, the student will be able to:

CO1: Understand the structure of plant cell and genome and its unique features

CO2: Design methods for plant propagation and regeneration

CO3: Choose methods to develop hybrid seeds and plan marker-assisted breeding

CO4: Plan strategies to perform genetic engineering of crop plants

CO5: Apply technology to improve the quality of crop plants

Mapping of Course Outcomes:

CO / PO	PO											
	1	2	3	4	5	6	7	8	9	10	11	12
CO1	M											
CO2	M		M		H							M
CO3	M	M	H	M	H							
CO4	H	H	H		H							
CO5	H	H	H	H	H	H		H				H

Unit 1: Plant Cell Organization **9 hours**

Plant Cell introduction, Chloroplast, Mitochondria, Cell wall, Plasma membrane and other organelles. Plant Genome size, structure and Characteristics

Unit 2: Plant Tissue Culture **9 hours**

Totipotency, Plant tissue culture media, Plant Growth Regulators, Organogenesis, Cell suspension culture, Production of secondary metabolites, Micropropagation, Production of virus free plants- shoot meristem culture.

Unit 3: Plant Breeding and Molecular Markers **9 hours**

Conventional methods of crop improvement, Simple and complex inheritance, Hybrid seeds production, Molecular markers- AFLP, RFLP, RAPD, SSR markers, Marker-assisted selection for qualitative and quantitative traits.

Unit 4: Genetic Engineering **9 hours**

Agrobacterium biology and T-DNA transfer, Binary vector system, *Agrobacterium*-mediated plant transformation, Ti Plasmid. Direct DNA transfer methods in plants - particle bombardment method. Analysis of transgenic plants and CRISPR/Cas9 targeted genome editing technology.

Unit 5: Applications in crop improvement **9 hours**

Transgenic plants: Golden rice, BT Cotton, engineering protein for improved nutrition of edible crops and Improvement of fodder crops. Gene silencing technology and manipulation of metabolic pathways for production of healthy fatty acids.

Text Books:

1. Neal Stewart, Jr - Plant Biotechnology and Genetics: Principles, Techniques, and Applications - John Wiley & Sons Inc. USA - 2016 (2nd Edition)
2. Slater A., Nigel W., Scott, and Fowler MR - Plant biotechnology: The Genetic Manipulation of Plants - Oxford University Press, London - 2008 (2nd Edition)

Reference:

1. Khalid Rehman Hakeem, Parvaiz Ahmad and Munir Ozturk - Crop Improvement: New Approaches and Modern Techniques – Springer 2013.

214BIT1110	GENE MANIPULATION	L	T	P	C
		3	0	0	3

Course Objective(s):

To understand about replication, transcription and translation process. To develop knowledge in gene manipulation.

Course Outcomes:

At the end of the course, students would be able to

CO1: Differentiate genes, genomics and DNA

CO2: Explain the mechanisms of replication, transcription and translation

CO3: Understand about various enzymes and vectors

CO4: Describe the cloning and its strategies

CO5: Understand applications in gene manipulation

Mapping of Course Outcomes:

CO / PO	PO											
	1	2	3	4	5	6	7	8	9	10	11	12
CO1	H										M	
CO2				M				H				
CO3			H			M				H		
CO4		H						M	M			H
CO5			M		M							

UNIT I: Genes, Genomes and DNA **9 hours**

DNA as the genetic material –Organization of prokaryotic and eukaryotic genomes, supercoiling, repetitive DNA - Levels of DNA packaging in Eukaryotes C-value paradox- Coding and non- coding DNA – regulation of gene expression, factors influencing gene expression.

UNIT II: DNA Replication, Transcription and Translation 9 hours

Prokaryotic and eukaryotic DNA replication - mechanisms of DNA replication- - replication inhibitors - DNA Repair and recombination; Gene mutations - types of mutations - Suppression, RNA Polymerases - Initiation, elongation, termination mechanism of eukaryotic and prokaryotic transcription - prokaryotic and eukaryotic translation, mechanism of initiation, elongation and termination, Post transcriptional and post translational regulations

UNIT III: Enzymes & Vectors in Gene Manipulation 9 hours

Restriction nucleases: exo & endo nucleases, Enzymes in modification- Polynucleotide phosphorylase, DNase, Methylases and phosphatases, polynucleotide kinase, Ligases, RNase and their mechanism of action -Plasmids, Mammalian expression vectors, Phages, Cosmids, Fosmids, Phagemids, and Artificial chromosomes, Safety guidelines for recombinant DNA research, -mechanism of implementation of biosafety guidelines

UNIT IV: Cloning & Expression of Recombinant Protein 9 hours

Cloning strategies- restriction digestion - blunt and cohesive end ligation – design of linkers and adaptors - cloning after homopolymer tailing; Strategies for cloning PCR products, - Plasmid expression vectors and check orientation - Methods for protein expression: Strategies for purification of recombinant proteins, Random and Site directed mutagenesis, functional alteration of proteins - Construction of cDNA library, Construction of Genomic library, Screening and preservation of DNA libraries, DNA Sequencing

UNIT V: Applications of Gene Manipulation 9 hours

Application Microbial biotechnology: Genetic manipulation, Engineering microbes for the production of antibiotics and enzymes, Engineering microbes for the production of insulin, growth hormones, monoclonal antibodies, Engineering microbes for clearing oil spills

Text Book(s):

1. Friefelder. D., Molecular Biology, McGraw-Hill Companies, New York, USA, 5th Edition, 2013.
2. Primrose, S., B. and Twyman, R., M., Principles of Gene Manipulation and Genomics, Blackwell Publishing Co., 7thEdition, 2006.

Reference(s):

1. Clark, D.P. and Pazdernik, N.J., Molecular Biology, Elsevier Academic Press , 2nd Edition, 2013
2. Lodge, J., Lund, P., and Minchin, S., Gene Cloning, Taylor & Francis Group, ISBN: 0-7487-6534-4, 2007.